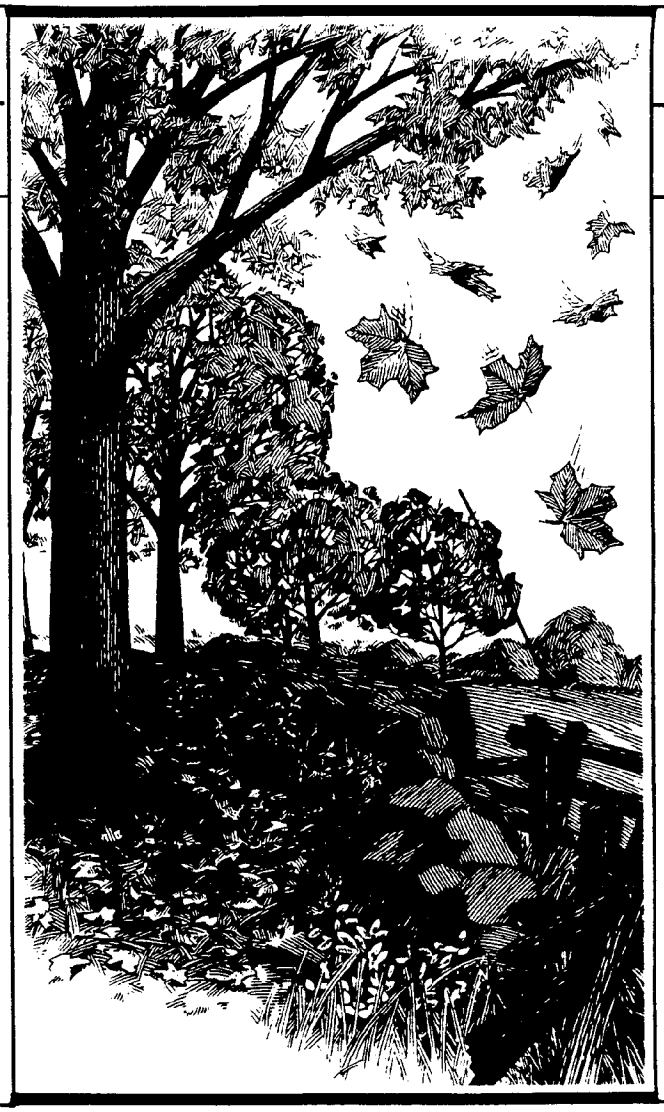
MURDERKILL RIVER CORRIDOR REPORT



Kent Conservation District **1986**

MURDERKILL RIVER CORRIDOR PROJECT REPORT

prepared by

Kent Conservation Disrict
and
Cooperating Agencies and Organizations

October 1986

This project was coordinated by Robert E. Williams, natural resource consultant, for the Kent Conservation District. Word processing was by Stephanie L. Kish, Kent Conservation District. Editing by Kathleen M. Jamison, Department of Natural Resources and Environmental Control. The project was partially funded by a grant from the Office of Ocean and Coastal Resources, National Oceanic and Atmospheric Administration, made available through the Delaware Department of Natural Resources and Environmental Control.

The Kent Conservation District is pleased to provide this report for the use of agencies, organizations, and landowners concerned with natural resources in the Murderkill River Corridor. The resource information and management options included should provide useful guidelines to decision makers on how best to use and manage the relatively undisturbed natural resources in the corridor.

The cooperation and assistance of all who participated with the District in this effort are deeply appreciated. Although heavy demands were made on project participants during their busiest season of the year, individual resource reports were completed, joint discussions of all reports were held, and the report was completed. We feel this project can point the way for even better understanding of resources and more effective cooperation as we look forward to carrying out many of the management options in the months ahead. The result will be the improvement and protection of the rich and diverse resources of the Murderkill River Corridor.

The District expresses its appreciation to the Office of Ocean and Coastal Resources Management for the funds made available through the Delaware Department of Natural Resources and Environmental Control which made this project possible. We also wish to thank the Delaware Department of Agriculture, Agland Preservation Section, for compiling and preparing the maps.

Sincerely,

Robert Winkler

Robert Winkler, Chairman
Kent Conservation District

MURDERKILL RIVER CORRIDOR PROJECT
REPORT

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SUMMARY

Although the natural resources of the Murderkill River Corridor are relatively undisturbed at this point in time, impending pressures from development and recreation will place greater stress on natural resources, private lands, facilities and services. The Murderkill River Corridor Project was carried out under the leadership of the Kent Conservation District to:

- inventory natural and cultural resources;
- analyze current land uses, trends, and problems;
- identify options for resource management;
- promote awareness and understanding; and
- provide responsible landowners, groups and agencies with management options for the management of natural resources in the Corridor.

Problems were identified and management options developed for all resources. Management options not only protect and improve one type of resource, they often will protect and/or improve adjacent resources.

This report will serve as a coordinating guide for programs that will make total conservation of all resources in the Murderkill River Corridor a reality.

Farmland

Farmland in the Murderkill River Corridor is the steeper or more rolling areas included in the one-quarter mile strip adjacent to the wetlands and bottomlands. These lands are primarily the well drained Sassafras sandy loam and Rumford loamy sand soils.

In the steeper and more rolling areas of the Corridor, soil losses will exceed three times the tolerable limits required to maintain productivity.

Eroded soil is deposited in ditches, streams, natural areas, and wetlands. More monitoring of irrigation water application is needed to prevent excess water use and runoff. Temporary covered field storage for poultry manure is a priority need. Public access, trespassing, littering, vandalism and off-road vehicles are growing nuisances.

Management Options

1. Cost-share programs of the Agricultural Stabilization and Conservation Service and the Kent Conservation District should be reviewed to see how erosion control practices might be more fully emphasized and encouraged along the steep slopes of the Corridor.
2. Information and education programs of the Extension Service, Kent Conservation District, Farm Bureau, and Pomona Grange should emphasize erosion control to protect farmland productivity and prevent off-site damages to wetlands and

natural areas. These agencies and groups should continue to furnish information about farmland preservation.

3. Development of alternative crops and cropping systems should be encouraged to diversify economic opportunities and provide for better soil management and reduce insect and disease problems.
4. Promote better irrigation water management.
5. Encourage the Delaware Development Office to recruit additional processing plants to support the productive capability of the area.
6. Encourage the development and distribution of educational materials and guidance on current technology for managing herbicides, pesticides, and plant nutrients to protect and improve water quality.
7. Resource agencies should provide adequate information to all farmers within the corridor to enable them to select the proper option within the 1985 sodbuster and swampbuster regulations to protect the resources and their eligibility to participate in various federal programs.

Fisheries

The Murderkill has a salinity range from zero in the tumbleholes below mill dams to well over 20 parts per thousand (ppt) at its confluence with the Delaware Bay. Consequently, there is a wide range of fishes available, depending on the season.

Water quality will have to improve within the Murderkill River system before fisheries can return to their historical significance. Lowered dissolved oxygen levels in the saline tidal portion of the river must be raised in order for oysters to have a reasonable chance to reestablish viable beds. However, as long as point discharges from sewage treatment plants enter the Murderkill River, the Department of Health and Social Services will not permit any harvesting of oysters for direct consumption. Nutrient levels in the Murderkill River, especially in the five freshwater ponds, will have to be reduced to prevent further eutrophication.

Management Options

Fisheries waters are impacted by land uses and disturbances occurring throughout the corridor. For this reason most management options listed under other land uses will have a beneficial effect on fisheries if carried out.

Wildlife

The diverse vegetative habitats in the Corridor provide support for a great number of birds and animals.

Potential problems include agricultural drainage and erosion; pesticides; development including marinas, dredging, housing, industrialization; off-road vehicles; utility and highway development; unregulated impoundments; substandard sewage effluent; stream bank erosion; common need encroachment; hunting pressure; poor forestry practices; and loss of habitat for game and nongame species.

Management Options

1. Increased land acquisition by appropriate state agencies as a means of protecting wildlife interests.
2. Increased private landowner contact and wildlife planning by the regional wildlife biologist and the nongame biologist through direct contact or referral by SCS or ASCS scientists.
3. Formation of an inter-agency planning team whose purpose would be to address problems as they arise, and to make recommendations to any public agency, private group or individual in order to maintain the high environmental standards which currently exist in the Murderkill River Corridor. This team would also serve as an inter-agency communication network to advise the appropriate agencies as problems develop.

Forests

Current timber types in the Murderkill River Corridor are tidal/swamp and bottomland and upland hardwoods. The mechanical damage created by poor harvesting practices and the associated natural site degradation is viewed as the most critical problem. Land conversion for residential construction and gravel pits are also considered as forest resource problems.

Management Options

1. The problems of environmentally damaging harvesting methods and practices can be reduced, if not eliminated, through forester site assessment and harvest planning, assuming owner dedication to use of such a plan. Forester planning includes use of selective harvesting and/or patch clearcutting in mature hardwood stands; and harvesting layout and sales contract restrictions including wet season restrictions, buffer zones (minimum 50 feet) along streams, skid trail layout, stream crossing limitations and others, as site conditions dictate.
2. The forest resource base and environmental concerns of residential construction, borrow pits and other forest land conversions can be minimized through use of stream bank buffer strips, site specific critical impact assessment prior to zoning changes, long-term land use planning, (such as low density planning for residential communities) and requirements for revitalization and revegetation of areas disrupted.
3. Site specific forester assessments for proposed land use

changes are currently available. Forestry guidelines can be developed which enumerate methods for minimizing adverse impacts of forestry practices and land use changes. Distribution through "currently in place" programs of cooperating agencies could help achieve owner acceptance.

4. Education and public relations seem to be a key element to success. Beyond this immediate need, it must again be recognized that in most cases the forests of Delaware are generally treated with monetary return in mind. Environmental protection measures and harvesting regulations are relatively costly. These costs are almost always passed on to the owner. Perhaps effective financial incentives to woodland owners can be developed through the combined experience of agencies involved in the Corridor project.
5. Many of the options for managing woodland for financial return while ensuring future forests and reducing environmental impacts are currently available. Increased knowledge of these management options is greatly needed. Though incentives are needed, investigation into what methods would achieve desired results should be undertaken.

Historical and Cultural

The Murderkill drainage is one of the best-known areas in Delaware for prehistoric archaeological sites. At present, about 125 sites are recorded in the Murderkill River Drainage. Murderkill Neck includes some of the earliest land patents in Kent County, dating to the 1680s. Forestry played a large part in the early economy of the area but gave way to farming as the forest land was cleared. Industrial efforts were tied primarily to agriculture.

Cultural resources - the physical remains of our past - are non-renewable; once destroyed, they are gone forever. Planning to incorporate the preservation of the past as we move into the future is essential. The Bureau of Archaeology and Historical Preservation is producing a plan that will identify primary research orientations and set goals and priorities for recording and preserving historically significant properties throughout the state.

Management Options

1. Several things can be done by both the public and the private sectors to protect cultural resources. For archaeological sites, the preferred alternative is preservation in place. Excavation is extremely expensive and time-consuming, and it is desirable to have a "bank" of preserved sites that could be investigated in the future with new techniques and research goals. Sites can be preserved by avoiding ground disturbing or erosional activities in their vicinity such as tree removal, deep plowing, construction work, or dirt-biking. Ways to accomplish this sort of site preservation include the

public acquisition through efforts such as the Natural Areas program administered by DNREC, or zoning restrictions or conditions in site areas.

2. On state-owned lands, archaeological sites are protected by the Antiquities Act, which forbids any kind of site excavation or disturbance, except for academic research by qualified professionals under a permit from the director of Historical and Cultural Affairs. In order to avoid accidental damage during normal maintenance or facilities expansions, DNREC has begun a program of archaeological surveys of its parks and other properties. One of the first parks for which this has been done is Killens Pond. This program is designed to delineate site areas and to produce a management plan to guide future park activities and protect culturally sensitive areas. These surveys are partially funded by the Historic Preservation Fund of the National Park Service, administered in Delaware by the Bureau of Archaeology and Historic Preservation.
3. Preservation of the historic landscape is also of concern in this area, which has one of the best preserved cultural landscapes in the state. Protection of agricultural lands and open spaces accords well with historic preservation goals for this area. In addition, the preservation of the built environment, both rural and town, is of considerable importance in maintaining a feeling of the past. The Bureau of Archaeology and Historic Preservation does surveys to identify and nominate historically significant buildings to the National Register of Historic Places. This action recognizes structures worthy of preservation and makes its owners eligible for certain tax benefits. While it gives a measure of protection from federal actions, listing in the National Register does not place any restrictions or demands on owners who are interested in retaining the historic appearance of their properties. The Bureau provides free technical advice on the best methods and approaches for doing so.

Natural Heritage

The natural heritage programs of the Division of Parks and Recreation are directed toward natural areas preservation and rare plant conservation.

Protection of natural areas is encouraged through inventory, registration, and dedication. The Statewide Natural Areas Inventory lists the Island Field Site, the Miocene Beds at Coursey Pond, and the river and adjacent woodlands and wetlands from Frederica to Coursey Pond and down Brown's Branch to McColley Pond. Natural areas and rare plants are often lost as a result of public and private actions.

Management Options

1. Contact landowners in defined natural areas to encourage registration and dedication of land.
2. Conduct a rare plant survey, beginning on public land.
3. Distribute a natural areas directory to appropriate public and private organizations.
4. Continue to work with public and private agencies to encourage conservation easements and environmentally sound land use practices.

Recreation

The 1984 **Delaware Outdoors**, the state comprehensive outdoor recreation plan (SCORP), identifies recreation facilities needed by the state's citizenry. In Kent County the following facilities are recommended for future development: bicycle trails, swimming pools, swimming - natural site, tennis courts, saltwater fishing, football/soccer fields, campgrounds, and golf courses. These represent in order of priority, the highest demand for recreation in the county.

The Killens Pond Master Plan recommends three swimming pools, a driving range and 18 hole golf course, four camping areas, three boat launch sites, a nature center, a riding stable, numerous picnic areas, and an extensive system of trails for nature/hiking, horseback riding, bicycling and canoeing. Most of these facilities fall within the SCORP findings.

Management Options

1. In order for Killens Pond State Park to include facilities recommended in both the Master Plan and the SCORP, more land must be purchased. A land acquisition program would also protect sensitive areas. Land in this rural area is becoming developed around the ponds and in strips of single-family housing along roadways. Though this is a problem, management options do exist.
2. Acquisition of properties adjacent to the existing park should continue. The area downstream between Killens and Coursey ponds should be considered for purchase. This would expand the state park (in accordance with the Master Plan) and provide protection along the Murderkill River Corridor. Acquisitions could be made as far north as Route 384 and south to Route 426. Housing development around McColley Pond precludes acquisitions; however, purchases could be targeted below the spillway on Brown's Branch, east of Route 388. Additionally, the river corridor west of the state park to Route 13 should be acquired.
3. In addition to fee-simple acquisition, conservation easements should be employed along the river corridor to assure protection. Kent County should be encouraged to cooperate in river corridor protection through appropriate zoning classification

in the county's Comprehensive Land Use Plan. The county also should be encouraged to provide more park and recreation areas within the study area.

Water Quality

Analysis of water quality data has been accomplished using the EPA-STORET computer system programs STAND and MRAN. The data indicates potential problems in the saltwater area, much of which has low dissolved oxygen levels during the summer months, with the lowest levels (at times near 1.0 mg/L) noted between river miles 3 and 9 above Frederica. High fecal coliform bacteria levels are also seen throughout this same stretch of river, in Spring Creek, and in the headwaters of the river near Felton. Low pH and alkalinity values are common to the freshwater segments of Browns Branch and the upper Murderkill. Evidence of a possible phenols problem in the saltwater area is also highlighted. These findings suggest that some designated uses may not be fully supported.

The Murderkill River has been chosen as the site of a pilot project under the Delaware "Stream Watch" program. The objective of this program is to encourage citizen involvement in the protection of stream water quality. The pilot project began in the spring of 1986.

Management of animal manure to prevent degradation of the surface and groundwaters of the state is being emphasized by DNREC, the Delaware Cooperative Extension Service, the Soil Conservation Service, and Conservation Districts.

Management Options

1. Work with all agencies and the Kent Conservation District to encourage the storage of animal manure under cover until the proper time to apply it on the land.
2. Encourage the adoption of the "MANURE" program to promote balanced use and management of manure, fertilizers, etc. to protect and improve water quality.
3. Stress protection of stream quality through Delaware "Stream Watch."

Wetlands

Wetlands provide important benefits and values to society. These include fish and wildlife values, environmental quality values, and socio-economic values. Wetlands include swamps, marshes, bogs and similar areas.

Areas of concern include ditching of wetlands for drainage only; lowering of the water table through ditching; loss of shallow aquifers from wells for agriculture and industry; water quality degradation; loss of habitat for wetland dependent species; negative impacts on threatened or endangered species; threats to wetlands from urban development; high wetlands

replacement costs; loss of natural shoreline through bulkheading; improper forestry practices on adjacent wetlands; erosion from farmland and resulting sedimentation of wetlands.

Management Options

1. Limits or prohibitions on urban or residential development in wetlands and 100 year flood plains.
2. Development of stormwater management plan and ordinances enforced in conjunction with sediment and erosion control plans.
3. Development of water conservation and control plans to minimize detrimental effects of drainage ditching.
4. Increased awareness, identification and protection of wetlands, their functions and values.
5. Best Management Practices (BMP's) employed in silviculture and agriculture adjacent to or in wetlands as a means of protecting and enhancing public and private natural resources.
6. Protection against shoreline loss by discouraging bulkheading and using alternative shoreline stabilization techniques and practices in areas of erosion and sedimentation.

Mosquito Problems

Salt-marsh mosquitoes breeding on several hundred acres of tidal wetlands cause extreme annoyance to residents of Bowers Beach, South Bowers, and Frederica. These species also can transmit encephalitis to man and horses, and heartworms to dogs. Although these areas are sprayed several times each year when major broods are in progress, insecticide control is costly, offers only temporary relief, and may have environmental drawbacks. Open water marsh management, including installation of selectively excavated ponds and ditches in breeding areas, encourages control of mosquito larvae by fish predation.

Management Options

1. Continue to emphasize Open water marsh management as the primary control measure in order to keep pesticide use to a minimum.

Urbanization

Practically all land in the Murderkill River Corridor is classified as agricultural-conservation districts except the towns of Bowers and Frederica. Several industrial sites are developed, including sand and gravel operations, International Latex Corporation, and the Kent Sewage Treatment Plant. Some strip development of single family dwellings along roads is occurring in

the corridor. A few housing developments have been built along lakes and scenic stretches near streams. To ensure that developments are undertaken in accordance with all state and local regulations, every subdivision in Kent County is subject to plan review by the Development Advisory Committee and must be approved by the Regional Planning Commission.

Management Options

1. The county should be encouraged to adopt the Land Evaluation and Site Assessment (LESA) process as a tool in decision making on land use changes involving agricultural land.
2. After the Comprehensive Land Use Plan is adopted, the county should consider ordinances to regulate littering, trespassing, and off-road vehicles to protect both private and public lands and the overall environmental quality of the corridor. Storm-water management should also be addressed.

Flood Plain Management

A flood plain is an area of land that, from time to time, has been or can reasonably be expected to be underwater. This simple definition covers areas that are overflowed by streams at times of high discharge, areas covered by abnormal tidal action, areas flooded by tides caused by winds, and even areas that are flooded by impairment of drainage.

Parts of the Murderkill River Watershed are subject to all four types of flooding. The flooding caused by poor drainage is outside of the area defined by the Murderkill River Corridor. The major problems in floodplain management exist in and around the coastal communities of Bowers and South Bowers. The raising of a residence above the current calculated 100 year flood does not necessarily prevent the hazards of flooding to these structures. Overflowed streams, periodically cause damages to structures in Frederica and to a few homes located within the flood plains of the Murderkill Corridor. Demand for developing the stream valley flood plain currently is low; however, a few homes have been built in the stream valley despite the risk of flooding.

Management Options

1. A near-term management option is the use of the conservation district technicians as a resource to the local communities in more adequately using the tools (flood hazard maps, flood elevations, reference elevations, management alternatives, etc.) that exist to reduce flood hazards.
2. A long-term management option is the active pursuit of a solution to the coastal community dilemna caused by increasing flood levels. Economics may be the focal point by which remedial benefits should be compared to the costs of measures required to reasonably protect against coastal high hazard conditions. The Division of Soil and Water Conserva-

tion, Beach Preservation Section is seeking funds to study the problem. Local support and assistance may be needed to fully understand the situation. This coordination may be a role for the conservation district.

INTRODUCTION

Background

The Murderkill River is one of the major drainage basins in central Delaware. It heads west of Felton and flows southeast for about 2.5 miles to join Black Swamp Creek just west of U.S. Highway 13 between Harrington and Felton. It then turns east and northeast and flows into Delaware Bay. Double Run, Hudson Branch, and Pratt Branch combine to join Spring Creek, the major northern tributary that joins the main stream near Frederica. Ash Gut and several smaller unnamed streams also join the river from the north. Brown's Branch, rising just south of Harrington, is the largest southern tributary.

Topography is gently rolling to nearly level. The elevations range from sea level on Delaware Bay to about 72 feet in the western and southwestern sectors. Soils are mainly the well-drained Sassafras and Rumford loamy sand, the moderately well drained Woodstown sandy loam, with smaller areas of poorly drained Fallsington loam and very poorly-drained Johnson silt loam and Pocomoke loam.

Precipitation averages about 46 inches annually and is fairly evenly distributed throughout the year, with a maximum in August and a minimum in February.

The Murderkill River Corridor was defined for this project as the poorly and very poorly drained alluvial soils on floodplains (G2-Natural Soil Group Map), all tidal marshes and swamps (G3-Natural Soil Group Map), and an adjacent strip to such areas one-quarter mile wide. This strip is primarily cropland and upland forest. The Corridor area includes primarily natural channels in alluvial soils. In some cases, corridor widths vary depending on special land use needs and considerations. The Corridor is bounded by U.S. Highway 13 on the west and the Delaware Bay on the east.

Purpose

The purpose of the Murderkill River Corridor Project is to organize a team approach and a public participation process under the leadership of the Kent Conservation District to assess all resources in the Corridor and to identify problems, opportunities, and management options for achieving total conservation and sustained use of the resources.

Need

The Murderkill River Corridor is a complex of diverse and relatively unspoiled resources and land uses. It provides a unique opportunity for cooperative effort to develop a better understanding of these resources in order that they might be managed and protected for the future benefit of all concerned.

Impending pressures from development and recreation will place greater stress on resources, private lands, facilities and services. The diversity of wetlands, forests, farmland, waters, wildlife habitat, historical and cultural resources, and urbanizing areas are supporting resources and not necessarily

competing resources. True cooperative effort towards achieving sound management of all resources is essential now, before major environmental disruptions occur.

Objectives

The primary objectives of this project are to:

- inventory all natural and cultural resources - wetlands, forests, waters, farmland, parks and natural areas, wildlife and fisheries habitat, historical and cultural sites, recreation potentials, and urbanizing areas;

- analyze current land uses, project trends and problems;

- identify potential needs and opportunities for land uses and options for resource management;

- promote awareness, understanding and cooperation with all landowners, organizations, and the public; and

- provide responsible landowners, groups and agencies with management options for the natural resources in the Murderkill River Corridor.

Project Report

The purpose of this report is to compile and assemble in one document, information essential to public decision makers, land managing agencies, and private landowners. Such information will include general natural resource assessments, discussion of problems, and a range of management options for consideration in making specific plans for resource conservation.

The report should serve as a basis for further cooperative effort and coordination of programs to make total conservation of all resources in the Murderkill River Corridor a reality.

This project was supported, in part, by a grant from the Office of Ocean and Coastal Resources Management, NOAA, under the provisions of the Federal Coastal Zone Management Act of 1972, as amended.

FARMLAND

Robert C. Hochmuth, Extension Agent,
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Background

Farmland in the Murderkill River Corridor is the steeper or more rolling areas included in the one-quarter mile strip adjacent to the wetlands and bottomlands. These lands are primarily the well-drained Sassafras sandy loam and Rumford loamy sand soils. Soybeans, corn, and small grain are the major crops and are used to support the poultry industry. In addition, production of vegetable crops for processing and fresh markets are equally important.

Trends and Problems

Sheet, rill, and gully erosion occur on approximately 10,000 acres of cropland in the corridor. Fields inadequately protected by cover crops and crop residues have soil losses of around four tons per acre per year from water and wind combined. These losses are within tolerable limits for maintaining long-term productivity. In the steeper and more rolling areas of the corridor soil losses well exceed three times the tolerable limits. Much of the eroded soil is deposited in ditches and streams. Several locations where sediment from eroding fields is being deposited in natural areas have been located.

No-till planting, a significant conservation cropping system, is widely used in the corridor to leave large amounts of cover and plant residues on the soil. However, on steeper fields with long slopes, additional measures such as critical area planting, diversions, water and sediment control structures with tile drain outlets and grassed waterways are needed. Examples of such complete cropland protection exist in the corridor.

Irrigation of cropland is on the increase using water supplied from deep wells, ponds and streams. Monitoring of salt content in the tidal streams is important. More monitoring of water applications is needed to prevent excess water use and runoff.

While some development of residences along roads and in scenic locations occurs, loss of farmland has taken place slowly to date. It will speed up in the future. On steeper areas, especially bluffs, severe erosion into the bottomlands, streams and lakes can occur unless careful planning is done and protective measures installed prior to land disturbance.

Animal waste management systems are needed throughout the corridor to reduce adverse impacts of manure on surface water runoff and on groundwater and to enable more effective use of plant nutrients. Typical systems include storage, rates and timing of land application. Temporary field storage for poultry manure utilizing covered structures is a priority need.

Private landowners, mostly farmers, are concerned with the problems of controlling or regulating public access and trespassing. Littering, vandalism and damage from off-road vehicles create a nagging and growing nuisance for farmers to deal with. Posting lands, encouraging hunters, hikers, and bikers to seek permission and creating an environmental ethic in the public at large all need to be examined. Ordinances and enforcement provisions need further study.

Managment Options and Possible Solutions

1. Cost-share programs of the Agricultural Stabilization and Conservation Service and the Kent Conservation District should be reviewed to see how erosion control practices might be more fully emphasized and encouraged along the steep slopes of the corridor.
2. Information and education programs of the Extension Service, Kent Conservation District, Farm Bureau, and Pomona Grange should emphasize erosion control to protect farmland productivity and prevent off-site damages to wetlands and natural areas. These agencies and groups should continue to furnish information about farmland preservation.
3. Development of alternative crops and cropping system should be encouraged to diversify economic opportunities and provide for better soil management and reduce insect and disease problems.
4. Promote better irrigation water management.
5. Encourage the Delaware Development Office to recruit additional processing plants to support the productive capability of the area.
6. Encourage the development and distribution of educational materials and guidance on current technology for managing herbicides, pesticides, and plant nutrients to protect and improve water quality.
7. Resource agencies will have to provide adequate information and education to all farmers within the corridor so they will be able to select the proper option within the 1985 sodbuster and swampbuster regulation to protect the resources and the eligibility of farmers to participate in various federal programs.

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FISHERIES

Charles A. Lesser, Manager of Fisheries,
Division of Fish & Wildlife, DNREC

Commercial Shellfish

Historically, the oyster beds located from the mouth of the Murderkill River and continuing up river to Webbs Landing were probably the most valuable of any of the river's shellfisheries. For years, Murderkill River oysters provided substantial income for local watermen and sustenance for local communities. These oysters were hand tonged until the 1930s when they were declared contaminated by the State due to high bacteria levels. However, they were still harvested and transplanted to Delaware Bay for depuration and subsequent harvest until 1974. Today most of the Murderkill oyster beds have died out due to disease and intermittent poor water quality.

Recreational Shellfish

Blue crabs are plentiful in the Murderkill River during years when the Delaware Bay blue crab population is high. They ascend the Murderkill River to the mill dams in years with low rainfall and higher than normal salinities occur upstream. In years with normal rainfall, they range from Bowers Beach to Frederica. Pots are used by recreational crabbers to capture blue crabs. Commercial crabbing is illegal throughout the Murderkill River. Recreational crabbers are limited to two pots per person.

Commercial Finfish

There are few historical records available on the commercial fisheries the Murderkill River supported. It was a spawning river for anadromous fishes. American shad spawned in the river and local fishermen awaited their return each spring. Striped bass, river herrings and white perch were also popular commercial fishes that used the Murderkill to spawn.. Today, only white perch and river herrings utilize the river as a spawning area. Biologists can only theorize about the decline of shad and striped bass in the Murderkill. Development of agricultural and residential areas and their allied uses of fertilizers and pesticides, septic waste systems, landfill operations, highway construction and storm water drainage have collectively degraded the water quality and aquatic habitat in the Murderkill River.

A small spring gill net fishery for white perch still exists. At most, only six or eight fishermen participate according to local watermen. The only viable commercial fishery today is in the spring and early summer when American eels are potted in the tidal portion of the river.

Recreational Finfish

Due to its proximity to Delaware Bay and its large drainage area, the Murderkill has a salinity range from zero in the tumbleholes below mill dams to well over 20 ppt at its confluence

with the Delaware Bay. Consequently, there is a wide range of popular sport fishes available depending on the season.

Anadromous fish, which are most frequently taken on their spring spawning run include white perch, alewife and blueback herring. The majority of the herring are taken in the tumbleholes where they concentrate during spawning. Fishermen use both hook and line and umbrella nets. White perch, although present throughout most of the year, are most sought during the spring when large adults enter the river from overwintering areas in Delaware Bay.

The resident freshwater species are most diverse in the tumbleholes but are distributed downstream into the brackish areas depending on each species' salinity tolerance. See Table 1 for a list of finfish collected throughout the Murderkill River.

Public access to the Murderkill River is available at North Bowers Beach, where there are public and private boat ramps and parking areas. Private boat launching facilities also are available at Webbs Landing, on the south side of the river on Delaware Route 121.

There are five freshwater state-maintained impoundments within the Murderkill drainage totalling 231 acres:

Andrews Lake - 18 Acres

Andrews Lake has a variety of game fishes such as largemouth bass, chain pickerel and yellow perch, which are abundant and grow rapidly. On December 6, 1980, a state record was set with a 10 lb 5 oz bass taken from Andrews Lake on a golden shiner. White perch are the most abundant panfish, but crappie, bluegill, and pumpkinseed also are common. Citation size fish for Delaware's Sportfishing Tournament are uncommon.

Golden shiners provide adequate forage for the bass and pickerel. The large weed beds serve as cover and spawning areas for the overabundant shiners.

Since most of the shoreline is residential, bank fishing is limited to the state-access area and along the road. A public boat ramp with sidestreet parking is available.

Coursey Pond - 58 Acres

Coursey Pond was recently drawn down for bridge and dam reconstruction. Refilling occurred in July 1986. The drawdown has temporarily altered the population structure of game fish in the pond. Largemouth bass have been restocked.

Coursey Pond has been excellent for carp fishing. Carp are extremely abundant and average between 1-2 lbs. They may be taken by hook and line, spear or bow and arrow. There are many chain pickerel, with large ones taken most often in the dense stands of vegetation. Largemouth bass are common, but relatively few large ones are taken. Crappie are also abundant and reach five inches in length within three years. Although not as abundant as crappie, the other panfishes (bluegill, pumpkinseed and white perch) have growth rates comparable to other Kent County ponds. Golden shiners and gizzard shad are the principal forage species. Occasional yellow and white perch of citation size are caught.

Public access for bank fishing is available below the spillway, along with a small picnic area. A public boat ramp gives access to the pond.

Killens Pond - 75 Acres

Carp fishing is excellent in Killens Pond, with most of the shoreline suitable for bank fishing. Dough balls and canned corn are the most popular baits. Carp reach good size in Killen Pond.

Chain pickerel are abundant and exhibit good growth, reaching six inches within two years. Largemouth bass are caught occasionally. Killen Pond always seems to rate high on the list of ponds yielding 5 lb bass as well as 1 lb crappie. Panfish are abundant and offer hours of recreation for the young cane pole fishermen. Bullhead catfish are over-abundant and should be removed by fishermen. Golden shiners provide suitable forage for the large game fish.

A severe algae bloom occurs annually, giving the pond a "green paint" appearance. The pond surface is periodically chemically treated to kill the algae, but the problem will continue as long as excess nutrients are present in the pond. Killens Pond rates high on the eutrophication scale.

A park user fee is required for fishermen from Memorial Day weekend through Labor Day. Carp may not be taken by bow and arrow or spear at Killen Pond. Boat access is limited to an unimproved launch area.

McColley Pond - 49 Acres

McColley Pond also was drawn down during 1985-86 due to bridge and dam reconstruction and was refilled in July 1986. This pond has a good population of largemouth bass and chain pickerel in addition to abundant carp. Crappie over 1 lb are common. Bluegill and yellow perch are numerous and exhibit fast growth.

The drawdown probably impacted the population structure of this pond, since it was subjected to tidal influence. However, carp and catfish should still be available and can provide sport in mid-summer. Cane pole fishermen can fill a stringer using dough balls, corn or night crawlers as bait. Bow and arrow or spear fishermen should find carp spawning in the shallows adjacent to the peninsula on the north shore. The pond was restocked in 1986 with largemouth bass.

Although a state lauching ramp is not available at McColley Pond, a car top boat can be carried to the pond in the vicinity of the water control structure. A private campground located off County Road 398 will permit launching from a ramp into McColleys for a small fee.

McGinnis Pond - 31 Acres

McGinnis Pond has a well-balanced fish population with a variety of species available to the angler. Largemouth bass are abundant and exhibit excellent growth for Delaware. Chain pickerel also are abundant and average over six inches by the end of their first year. Panfish, including white perch, bluegill, black crappie and pumpkinseed, provide hours of enjoyment for the cane poler as well as the more expensively equipped fisherman.

Crappie are often taken in the vicinity of brush shelters placed in the pond by the Division of Fish and Wildlife. Golden shiners and bluespotted sunfish are the primary forage fishes.

McGinnis Pond is one of the deeper ponds in the state and is subject to temperature stratification. In the summer, there often are three distinct temperature layers within the pond. These consist of a warm surface layer, a thin intermediate layer and a colder bottom layer. Since the bottom water layer does not circulate in the summer, its oxygen concentrations become depleted and the bass are forced upward into warmer water than they would normally prefer.

In 1981, the five ponds in the Murderkill Corridor supported nearly 19,000 man-days of sportfishing with an estimated catch of over 75,000 fish.

Water quality will have to improve within the Murderkill River system before fisheries can return to their historical significance. Lowered dissolved oxygen levels in the saline tidal portion of the river must be raised in order for oysters to have a reasonable chance to reestablish viable beds. However, as long as point discharges from sewage treatment plants enter the Murderkill River, the Department of Health and Social Services will not permit any harvesting of oysters for direct consumption. Nutrient levels in the Murderkill River, especially in the five ponds, will have to be further reduced to prevent further eutrophication.

Management Options:

Management options listed for other resource areas impact on fisheries.

References

Department of Natural Resources & Environmental Control. Division of Fish and Wildlife. Delaware's Public Ponds. Rev. 1986

WILDLIFE

Janis Thomas, Nongame and Endangered Species
Coordinator, Div. of Fish & Wildlife, DNREC
Lynn Herman, Regional Wildlife Biologist,
Div. of Fish & Wildlife, DNREC

Introduction

The Murderkill River and surrounding land corridor represent a unique, relatively undisturbed environment for both game and nongame species. The Delaware Division of Fish and Wildlife, whose primary responsibility is to manage the state's faunas, recognizes the importance of this area. Acquisition of the 738-acre Penuel Tract of the Milford Neck Wildlife Area, for example, shows an interest in protecting and managing a portion of the river corridor. Approximately 1 1/2 miles of the corridor on the south side of the Murderkill River (see the attached resource inventory map) is currently under the jurisdiction of the Wildlife Division.

The diverse vegetative habitats within the corridor provide niches for an abundance of animal species. Several wildlife inventories are currently underway which will yield information pertaining to the Murderkill River Corridor.

Species Inventory

To better understand the status of birds in Delaware, a project is underway to gather and publish data on their breeding and seasonal distribution. Through the cooperative efforts of the Delmarva Ornithological Society, Delaware Nature Education Society, the Delaware Museum of Natural History, the Department of Natural Resources and Environmental Control's nongame program and volunteers statewide, data gathering for this five-year project began in 1983. Publication of The Birds of Delaware is scheduled for the fall of 1988. The following bird list has been compiled from the breeding bird atlas project, nongame program studies and field guide distributional maps.

Due to the diversity of habitat in the Murderkill River Corridor (wetlands, fields, wooded areas and shore line) the area contains a large number of species. Some are year-round residents while others are migratory. The bald eagle has been reported frequently in the area while the peregrine falcon and piping plover may be found here. These three species are listed on the state and federal endangered species lists.

Murderkill River Corridor Bird List

Common Loon (Gavia immer)
Red-throated Loon (Gavia stellata)
Horned Grebe (Podiceps auritus)
Pied-billed Grebe (Podilymbus podiceps)
Red-necked Grebe (Podiceps grisegena)

Double-crested Cormorant (Phalacrocorax auritus)
Whistling Swan (Olor columbianus)
Snow Goose (Chen caerulescens)
Canada Goose (Branta canadensis)*
American Black Duck (Anas rubripes)

Gadwall (Anas fulvigula)
Mallard (Anas platyrhynchos)*
Common Pintail (Anas acuta)
American Wigeon (Anas americana)
Wood Duck (Aix sponsa)*

Northern Shoveler (Anas clypeata)
Blue-winged Teal (Anas discors)
Green-winged Teal (Anas crecca)
Canvasback (Aythya valisineria)
Redhead (Aythya americana)

Ring-necked Duck (Aythya collaris)
Lesser Scaup (Aythya affinis)
Greater Scaup (Aythya marila)
Common Goldeneye (Bucephala clangula)
Bufflehead (Bucephala albeola)

Ruddy Duck (Oxyura jamaicensis)
Common Merganser (Mergus merganser)
Red-breasted Merganser (Mergus serrator)
Hooded Merganser (Lophodytes cucullatus)
American Coot (Fulica americana)

Common Gallinule (Gallinula chloropus)
Iceland Gull (Larus glaucoides)
Herring Gull (Larus argentatus)
Ring-billed Gull (Larus delawarensis)
Greater Black-backed Gull (Larus marinus)

Laughing Gull (Larus atricilla)*
Bonaparte's Gull (Larus philadelphia)
Least Tern (Sterna albifrons)*
Common Tern (Sterna hirundo)
Forster's Tern (Sterna forsteri)

Black Skimmer (Rynchops niger)
Great Blue Heron (Ardea herodias)*
Little Blue Heron (Florida caerulea)
Tricolored Heron (Hydranassa tricolor)
Great Egret (Casmerodius albus)

Snowy Egret (Egretta thula)
Cattle Egret (Bubulcus ibis)
Black-crowned Night Heron (Nycticorax nycticorax)*
Yellow-crowned Night Heron (Nyctanassa violacea)
Green Heron (Butorides striatus)*

Least Bittern (Ixobrychus exilis)
American Bittern (Botaurus lentiginosus)
Glossy Ibis (Plegadis falcinellus)
Virginia Rail (Rallus limicola)
King Rail (Rallus elegans)

Clapper Rail (Rallus longirostris)
Sora (Porzana carolina)
Black Rail (Laterallus jamaicensis)
American Oystercatcher (Haematopus palliatus)
Black-bellied Plover (Pluvialis squatarola)

Ruddy Turnstone (Arenaria interpres)
Piping Plover (Charadrius melodus)**
Semipalmated Plover (Charadrius semipalmatus)
Killdeer (Charadrius vociferus)*
American Woodcock (Philohela minor)*

Common Snipe (Capella gallinago)
Red Knot (Calidris canutus)
Sanderling (Calidris alba)
Dunlin (Calidris alpina)
Willet (Catoptrophorus semipalmatus)

Greater Yellowlegs (Tringa melanoleuca)
Lesser Yellowlegs (Tringa flavipes)
Purple Sandpiper (Calidris maritima)
Spotted Sandpiper (Actitis macularia)
Semipalmated Sandpiper (Calidris pusilla)

Western Sandpiper (Calidris mauri)
White-rumped Sandpiper (Calidris fuscicollis)
Common Bobwhite (Colinus virginianus)*
Turkey (Meleagris gallopavo)*
Sharp-shinned Hawk (Accipiter striatus)
Cooper's Hawk (Accipiter cooperii)

Northern Goshawk (Accipiter gentilis)
Northern Harrier (Circus cyaneus)
Red-tailed Hawk (Buteo jamaicensis)*
Rough-legged Hawk (Buteo lagopus)
Red-shouldered Hawk (Buteo lineatus)

Broad-winged Hawk (Buteo platypterus)
Bald Eagle (Haliaeetus leucocephalus)**
Osprey (Pandion haliaetus)
Turkey Vulture (Cathartes aura)*
Black Vulture (Coragyps atratus)*

American Kestrel (Falco sparverius)
Merlin (Falco columbarius)
peregrine Falcon (Falco peregrinus)**
Short-eared owl (Asio flammeus)
Common Screech owl (Otus asio)

Long-eared Owl (Asio otus)
Great-horned Owl (Bubo virginianus)*
Barred Owl (Strix varia)*
Barn Owl (Tyto alba)
Saw-whet Owl (Aegolius acadicus)

Mourning Dove (Zenaida macroura)*
Rock Dove (Columba livia)*
Yellow-billed Cuckoo (Coccyzus americanus)*
Black-billed Cuckoo (Coccyzus erythropthalmus)*
Common Nighthawk (Chordeiles minor)*

Whip-poor-will (Caprimulgus vociferus)*
Chuck-will's-widow (Caprimulgus carolinensis)*
Ruby-throated Hummingbird (Archilochus colubris)*
Belted Kingfisher (Megaceryle alcyon)*
Red-headed Woodpecker (Melanerpes erythrocephalus)

Pileated Woodpecker (Dryocopus pileatus)
Common Flicker (Colaptes auratus)*
Red-bellied Woodpecker (Melanerpes carolinus)*
Yellow-bellied Sapsucker (Sphyrapicus varius)
Downy Woodpecker (Picoides pubescens)*

Hairy Woodpecker (Picoides villosus)*
Eastern Kingbird (Tyrannus tyrannus)*
Great Crested Flycatcher (Myiarchus crinitus)*
Eastern Phoebe (Sayornis phoebe)*
Eastern pewee (Contopus virens)*

Acadian Flycatcher (Empidonax virescens)*
Willow Flycatcher (Empidonax traillii)
Horned Lark (Eremophila alpestris)*
Water Pipit (Anthus spinoletta)
Purple Martin (Progne subis)*

Barn Swallow (Hirundo rustica)*
Tree Swallow (Iridoprocne bicolor)*
Rough-winged Swallow (Stelgidopteryx ruficollis)*
Bank Swallow (Riparia riparia)*
Chimney Swift (Chaetura pelagica)*

Fish Crow (Corvus ossifragus)*
American Crow (Corvus brachyrhynchos)*
Blue Jay (Cyanocitta cristata)*
Carolina Chickadee (Parus carolinensis)*
Tufted Titmouse (Parus bicolor)*

White-breasted Nuthatch (Sitta carolinensis)
Red-breasted Nuthatch (Sitta canadensis)
Brown Creeper (Certhia familiarus)
House Wren (Troglodytes aedon)
Winter Wren (Troglodytes troglodytes)

Carolina Wren (Thryothorus ludovicanus)*
Marsh Wren (Cistothorus palustris)*
Sedge Wren (Cistothorus platensis)
Ruby-crowned Kinglet (Regulus calendula)
Golden-crowned Kinglet (Regulus satrapa)

Blue-gray Gnatcatcher (Polioptila caerulea)*
Brown Thrasher (Toxostoma rufum)*
Gray Catbird (Dumetella carolinensis)*
Northern Mockingbird (Mimus polyglottos)*
Eastern Bluebird (Sialia sialis)*

Wood Thrush (Hylocichla mustelina)*
Hermit Thrust (Catharus guttatus)
Cedar Waxing (Bombycilla cedrorum)*
Red-eyed Vireo (Vireo olivaceus)*
Warbling Vireo (Vireo gilvus)

Yellow-throated Vireo (Vireo flavifrons)*
White-eyed Vireo (Vireo griseus)*
Northern Parula Warbler (Parula americana)
Prothonotary Warbler (Protonotaria citrea)
Black-and-white Warbler (Mniotilta varia)*

Yellow-rumped Warbler (Dendroica coronata)
American Redstart (Sctophaga ruticilla)*
Pine Warbler (Dendroica pinus)*
Prairie Warbler (Dendroica discolor)
Palm Warbler (Dendroica palmarum)

Yellow Warbler (Dendroica petechia)*
Hooded Warbler (Wilsonia citrina)
Kentucky Warbler (Oporornis formosus)
Common Yellowthroat (Geothlypis trichas)*
Yellow-breasted Chat (Icteria virens)

Louisiana Waterthrush (Seiurus motacilla)
Ovenbird (Seiurus aurocapillus)*
Red-winged Blackbird (Agelaius phoeniceus)*
Brown-headed Cowbird (Molothrus ater)*
Rusty Blackbird (Euphagus carolinus)

Common Grackle (Quiscalus quiscula)
Eastern Meadowlark (Sturnella magna)*
European Starling (Sturnus vulgaris)*
Orchard Oriole (Icterus spurius)*
Northern Oriole (Icterus galbula)*

Summer Tanager (Piranga rubra)*
Scarlet Tanager (Piranga olivacea)*
House Sparrow (Passer domesticus)*
Northern Junco (Junco hyemalis)
Snow Bunting (Plectrophenax nivalis)

Northern Cardinal (Cardinalis cardinalis)*
House Finch (Carpodacus mexicanus)*
Purple Finch (Carpodacus purpureus)
Pine Siskin (Carduelis pinus)
European Goldfinch (Carduelis carduelis)*

Blue Grosbeak (Guiraca caerulea)
Evening Grosbeak (Hesperiphona vespertina)
Indigo Bunting (Passerina cyanea)*
Rufous-sided Towhee (Pipilo erythrophthalmus)*
White-crowned Sparrow (Zonotrichia leucophrys)

White-throated Sparrow (Zonotrichia albicollis)
Chipping Sparrow (Spizella passerina)*
Field Sparrow (Spizella pusilla)*
Swamp Sparrow (Melospiza georgiana)
Grasshopper Sparrow (Ammodramus savannarum)*

Fox Sparrow (Passerella iliaca)
Song Sparrow (Melospiza melodia)*
Vesper Sparrow (Pooecetes gramineus)*
Savannah Sparrow (Passerculus sandwichensis)
Sharp-tailed Sparrow (Ammospiza caudacuta)
Seaside Sparrow (Ammospiza maritima)

*possible breeding

**Federal and State Endangered or Threatened Species

Herpetofauna of the Murderkill River Watershed

James White, Naturalist, Delaware Nature Education Society

A study of the distribution and abundance of reptiles and amphibians in Delaware began in 1985 with Nongame Tax Checkoff Funds. This five-year study conducted by the Delaware Nature Education Society will include a distributional survey of the herpetofauna of Delaware, a compilation of natural history information, pinpointing of breeding areas and identification of rare and endangered species. Principal researchers are Dr. Rudolf G. Arndt, Stockton State College, James F. White, Delaware Nature Education Society, and Joseph M. McLaughlin, Jr. The following list is from data collected to date.

Species	Habitat
Red-spotted newt Notophthalmus v. viridescens	-ponds, freshwater marshes
Spotted salamander Ambystoma maculatum	-wet woodlands
Marbled salamander Ambystoma opacum	-sandy woodlands
Northern dusky salamander Desmognathus f. fuscus	-rocky streams
Northern two-lined salamander Eurycea b. bislineata	-rocky streams
Four-toed salamander* Hemidactylium scutatum	-wet woodlands associated with boggy areas
Red-backed salamander Plethodon c. cinereus	-woodlands
Eastern spadefoot Scaphiopus h. holbrooki	-woodlands, old fields, cultivated areas with sandy soil
Bullfrog Rana catesbeiana	-ponds, slow moving rivers, freshwater marshes
Green frog Rana clamitans melanota	-ponds, freshwater marshes, swamps

Pickerel frog *Rana palustris*	-ponds, freshwater marshes
Southern leopard frog *Rana utricularia*	-ponds, freshwater marshes, swamps
Wood frog *Rana sylvatica*	-woodlands
Fowler's toad *Bufo woodhousei fowleri*	-wet woodlands, old fields, cultivated fields
Northern cricket frog *Acris crepitans*	-wet woodland, ponds, freshwater marshes
Gray treefrog* *Hyla chrysocelis*	-wet woodlands associated with freshwater marshes or ponds
Common treefrog *Hyla versicolor*	-wet woodlands associated with freshwater marshes or ponds
Green treefrog* *Hyla cinerea*	-wet woodlands, freshwater marsh perimeters
Northern spring peeper *Hyla crucifer*	-wet woodlands, freshwater marsh
New Jersy chorus frog *Pseudacris triseriata*	-wet woodlands, freshwater marsh, ponds
Snapping turtle *Chelydra s. serpentina*	-freshwater ponds, rivers, streams, brackish water
Eastern mud turtle *Kinosternon s. subrubrum*	-freshwater ponds, rivers streams, brackish water
Stinkpot *Sternotherus odoratus*	-Freshwater ponds, rivers, streams
Eastern painted turtle *Chrysemys p. picta*	-all freshwater habitats, slightly brackish water
Red-bellied turtle *Chrysemys r. rubriventris*	-lakes, ponds, freshwater parts of tidal rivers
Spotted turtle *Clemmys guttata*	-ponds, muddy streams, boggy areas
Eastern box turtle *Terrapene c. carolina*	-woodlands, old fields, wet meadows
Fence lizard *Sceloporus undulatus hyacinthinus*	-woodlands, old fields, old foundations
Five-lined skink *Eumeces fasciatus*	-woodlands, old fields
Eastern worm snake *Carphophis a. amoenus*	-wet woodlands, under debris and leaf litter
Northern black racer *Coluber c. constrictor*	-old fields and woodlands
Ring neck snake *Diadophis p. punctatus*	-wet woodlands, old fields
Black rat snake *Elaphe o. obsoleta*	-old fields, barns, woodlands, farmlands
Eastern hognose snake *Heterodon platyrhinos*	-sandy woodlands, old fields, dunes

Eastern kingsnake* *Lampropeltis g. getulus*	-woodlands, river swamps, farmlands
Northern water snake *Nerodia s. sipedon*	-all freshwater and brackish water areas
Rough green snake *Opheodrys aestivus*	-vines, bushes, trees near water
Eastern ribbon snake *Thamnophis s. sauritus*	-wet meadows, old fields, woodlands, near streams
Eastern garter snake *Thamnophis s. sirtalis*	-wet meadows, marshes, old fields

*High probability of occurence, more research needed

Murderkill River Corridor Mammals

Mammals found within the corridor are as diverse as the birds, reptiles and amphibians. Many of the most popular game species are represented and quality hunting is available throughout most of the corridor. The following list was derived from Fish and Wildlife records and field guide distributional maps:

Masked shrew (*Sorex cinereus*)
Shorttail shrew (*Blarina brevicauda*)
Least shrew (*Cryptotis parva*)
Earstern mole (*Scalopus aquaticus*)
Starnose mole (*Condylura cristata*)

House mouse (*Mus musculus*)
White-footed mouse (*Peromyscus leucopus*)
Meadow jumping Mouse (*Zapus hudsonius*)
Meadow vole (*Microtus pennsylvanicus*)
Pine vole (*Microtus pinetorum*)

Rice rat (*Oryzomys palustris*)
Norway rat (*Rattus norvegicus*)
Southern flying squirrel (*Glaucomys volans*)
Muskrat (*Ondatra zibethicus*)
Longtil weasel (*Mustela frenata*)

Mink (*Mustela vison*)
Opossum (*Didelphis virginiana*)
Eastern cottontail (*Sylvilagus floridanus*)
Woodchuck (*Marmota monax*)
Eastern chipmunk (*Tamias striatus*)

Eastern gray squirrel (*Sciurus carolinensis*)
Beaver (*Castor canadensis*)
Red fox (*Vulpes vulpes*)

Gray fox (Urocyon cinereoargenteus)
Raccoon (Procyon lotor)

Striped skunk (Mephitis mephitis)
River otter (Lutra canadensis)
Whitetail deer (Odocoileus virginianus)
Little brown myotis (Myotis lucifugus)
Silver-haired bat (Lasionycteris noctivagans)

Eastern pipistrel (Pipistrellus subflavus)
Big brown bat (Eptesicus fuscus)
Red bat (Lasiurus borealis)
Hoary bat (Lasiurus cinereus)

Nongame Management

A nongame biologist, Janis Thomas, was hired by the Delaware Division of Fish and Wildlife in 1984, with funding provided by a Nongame Tax Checkoff on the Delaware individual income tax form. Responsibilities include development of programs directed toward non-consumptive activities such as bird watching and feeding, as well as research and management activities involved with endangered and nongame species.

As a first priority, a draft Nongame and Endangered Species Plan was prepared which defined problems and objectives of the nongame program in Delaware. General in scope by necessity, the plan addresses needs on a statewide basis. While not defining management objectives specifically for the Murderkill River, it provides an excellent framework for decisions concerning impacts on nongame species within the corridor. (See references to this section for Delaware's draft nongame plan).

Game Management

Effective January 1, 1986, the Delaware Division of Wildlife was reorganized under a plan originally developed by past director Norman G. Wilder. This plan divides the state into four management regions. Associated with each region is a regional wildlife biologist whose responsibilities include managing state wildlife areas, acting as liaison between hunters and the Delaware Division of Wildlife, and consulting with private landowners to encourage good wildlife management practices. The Murderkill River falls within Region 3 and in January 1986, Lynn Herman was employed as the regional wildlife biologist.

The Delaware Division of Fish and Wildlife owns a small portion of the Murderkill River Corridor. Administered as part of the Milford Neck Wildlife Area, the Penuel Tract totals approximately 738 acres of upland forest, agricultural lease and marshland adjacent to the Murderkill River. Acreage breakdown is as follows:

Agricultural Lease.	.276 acres
Division Maintained Agriculture . .	15 acres
Forestland.	.255 acres
Marshland	.192 acres
TOTAL	738 acres

While a comprehensive management plan has not been written for this tract, a maintenance management plan has been in effect since acquisition of the area in 1978. As outlined by Division Director William Wagner, the writing of comprehensive management plans for all wildlife areas under the reorganized structure. Currently the regional biologists are working on the format that these management plans should follow and it is hoped that they will be forthcoming. The Penuel Tract will be given first priority within Region 3 since a limited management framework currently exists for the area. The following summary briefly outlines the current management practices for the Penuel Tract.

Agricultural leases are paramount to the continued management of wildlife species on state owned lands. Guidelines have been developed which are designed to maximize benefits to wildlife species. The Penuel lease is for a period of six years, with the lease contract going to the highest closed bid. Normally a 50:50 planting ratio of corn to soybeans is specified within the contract. At Penuel, permission was given for a single crop of soybeans during the 1985 and 1986 growing seasons because limtied success has been achieved with corn in the past. It is anticipated that a new agricultural lease will be negotiated beginning with the 1987 growing season.

A trapping lease is issued on a yearly basis by sealed bids for the marshland area which is primarily composed of spartina and cattails. The only exception is that a small refuge area has been designated in the eastern portion of the marsh and is not open to trapping at any time. Box trapping for raccoons is permitted in the upland areas by the trapping leasee.

Approximatley 15 acres are being tilled by the Wildlife Division to provide dove hunting during the fall season. Dwarf sunflowers and sorghum are planted annually and mowed at various times throughout the fall to provide quality dove hunting.

The forestlands within the tract are highly variable in both size and age classes and consist of a variety of tree species, including American beech, tulip poplar, white oak and sweetgum. Recently, the State Forestry Section has been evaluating the timber resources on wildlife areas within Region 3. To date a plan for the Penuel Tract has not been completed. It is hoped that this area will be evaluated next and that the forest plan will be incorporated into the comprehensive wildlife plan.

In 1984, wild turkeys were released near the main tract of the Milford Neck Wildlife Area east of Milford. Numerous sightings reported near the Penuel Tract suggest that some of the birds may have settled within or near this tract. Management of turkeys will receive consideration in the comprehensive wildlife plan.

Waterfowl hunting is limited on the Penuel Tract to four state-owned blinds located adjacent to the Murderkill River. A first come, first served basis regulates the use of these blinds. Upland game hunting is open from 1/2 hour before to 1/2 hour after sunset. Specific regulations are provided on a map of the Penuel Tract which is available at the Dover Fish and Wildlife office. Statewide seasons for all game are set annually and are provided in the state hunting guide.

Harvest figures for various game species are not available for site specific areas such as the Penuel Tract. The statewide hunter survey which is conducted annually does not single out the various wildlife areas within the state or harvest data. It is not possible therefore to provide species harvest information for this area. Generally however, good quality habitat is provided and hunting is comparable to other wildlife areas statewide.

The completion of a comprehensive management plan for the Penuel Tract will enable more controlled management for various game species on the area.

Potential Problems or Areas of Concern to the Delaware Division of Wildlife

The following list of concerns has been determined for the Murderkill River Corridor. As development proceeds on lands adjacent to the Murderkill River, consideration should be given to these potential environmental impacts.

1. Tax ditching designed to drain upland agriculture areas.
2. Agricultural erosion.
3. Chemical contamination from agricultural spraying of of pesticides and herbicides.
4. Wildlife habitat loss through development within the corridor, including marinas, dredging, housing and industrial expansion.
5. Unregulated use of off-road vehicles such as dirt bikes, three wheelers and four wheel drive trucks.
6. Powerline or highway development.
7. Unregulated impoundment construction and management,
8. Substandard sewage effluent from the Kent County sewage treatment plant.
9. Stream bank erosion within the Murderkill Watershed.
10. Phragmites encroachment into wetland areas.
11. Increased hunting pressure on waterfowl; unregulated duck blind and goose pit construction.
12. Sewage sludge use as fertilizer on agricultural or forest lands.
13. Unregulated forestry practices.
14. Habitat loss for game and nongame species, as well as rare, threatened or endangered species as defined by the U.S. Fish and Wildlife Service and the Delaware Division of Fish and Wildlife.

Management Options

The following suggestions are offered as a means of minimizing or controlling environmental impacts within the Murderkill River Corridor.

1. Increased land acquistion by appropriate state agencies as a means of protecting wildlife interests.
2. Increased private landowner contact and wildlife planning by the regional wildlife biologist and the nongame biologist through direct contact or referral by SCS or ASCS scientists.
3. Formation of an inter-agency planning team whose purpose would be to address problems as they arise, and to make recommendations to any public agency, private group or individual in order to maintain the high environmental standards which currently exist in the Murderkill River Corridor. This team would also serve as an inter-agency communication network to advise the appropriate agencies as problems develop.

REFERENCES

Thomas, Janis E., Delaware Division of Fish and Wildlife, Department of Natural Resources and Environmental Control. Nongame and Endangered Species Plan 1985-1990.

FOREST RESOURCES

John M. Schwalm and Nancy Milliken Willis,
Foresters, Delaware Department of Agriculture,
Forestry Section

Introduction

The forests of the Murderkill River Watershed are primarily diverse hardwood woodlands. In total, they encompass 16,412 acres of which 229 acres are coniferous plantations. Specific figures for the Murderkill River Corridor are not available.

Aside from historical value and current status data sections which follow, the role these forests play in impacting the Murderkill River is dependent on two factors. The first relates to ownership goals and utilization of proper forest management and harvesting practices.

The second is the potential impact of the management and harvesting techniques used upstream of the Corridor study area. For instance, excessive harvesting during the spring along a tributary can increase erosion sediments to the main Corridor. Therefore, from a forestry viewpoint the levels of management and use of proper harvesting practices throughout the entire Murderkill River drainage area need to be considered.

Historical Values

Throughout the Murderkill drainage area the primary use of the forest is wood for the farm or home. Removal of trees for firewood, lumber, posts, fence boards, duck blinds, and many other products has continued since the area was first settled.

The clearing of woodland for cropland was at its highest level approximately 100 years ago. The extent of clearing was determined primarily by soil wetness or drainage. Unlike other areas within the state, little of the well-drained cropland was abandoned during the Depression years. Therefore, most converted woodland has remained in cropland or home use since first cleared.

Clearing of woodland continues, to date, at a moderate to low rate for residential construction. This situation is attributed to a perceived desire to live in wooded areas, as well as the suitability of the upland sites for such use.

Along the Murderkill Corridor itself, wood was most likely used for boat or ship lumber. There were no sawmills, basket mills for forest product manufacturing facilities along the Corridor; however, transportation of forest products may have occurred and wood may also have been used for stream production.

Current Forest Condition and Timber Types

Present forests exist primarily due to a relatively high water table preventing equipment access throughout the year, especially during agricultural crop planting, cultivating and harvest seasons.

Little over-mature timber exists in the area due to continued farm use and harvesting. Also, nearly all present timber stands are even-aged as a result of the use of the clearcut harvest method in the past. (The term "clearcut" means harvest of all

merchantable stems, generally trees 12 inches in diameter and greater in hardwood forests, with a nine inch minimum for sawtimber in softwood forests.)

The other land treatment practice which modified the forest was construction of drainage ditches, normally hand dug. In these areas, the present forest composition is partially the result of the modification in the surface water table.

The overall health of the forests is good. Except for woodlots west of Route 13, gypsy moth populations are low with little, if any, defoliation damage. Also, these forests have fared well through the drought of the past three years.

Tidal/Swamp Forests

Tidal forests occupy 684 acres of the Murderkill River Watershed. The tree species which predominate in these forests are black (tupelo) gum, red maple and sweetgum, with limited areas of green ash. The timber grade is poor, as well as the rate of growth. These forests are classified (by U.S. Forest Service definition) as non-commercial forest land, unable to produce 20 cubic feet of fiber per acre per year and/or withdrawn from timber utilization. For these reasons, management of tidal forests for a timber crop is not financially/economically viable.

However, management for other uses such as wildlife is recommended.

Bottomland hardwoods

Bottomland hardwood forests comprise 9,299 acres of the Murderkill River Watershed. The predominant species of this type are swamp chestnut oak, willow oak, chestnut oak, swamp white oak, red maple, sweetgum, black (tupelo) gum, black cherry, southern red oak and Virginia pine. Other associated species depend on available surrounding seed source and tolerance for standing water during the growing season. Timber grade and growth are fair overall, and where tidal influence is not present are better. These forests are classified as commercial forest land, unless withdrawn from timber utilization. Management for timber production is possible and economically practical. Special site protection measures are strongly recommended to ensure the long-term economic practicality on most of the bottomland hardwood sites. The optimal management regime entails selection harvest of mature trees with consideration for time of year, slope, soil fragility, drainage patterns and species composition. Clearcutting is not recommended for maintaining species composition, grade and site quality.

Upland Hardwoods

The upland hardwood forests occupy 6,200 acres of the watershed. The predominant species are yellow poplar, white oak, beech, green ash, sweetgum, southern red oak, black oak, and pin oak, with scattered pockets of loblolly pine. The growth and timber grade are fair to good, dependent on exact site conditions. The upland hardwoods of this area are classified as commercial forest land, unless withdrawn from timber utilization. The best financial return from forest management is possible for the Corridor area in this timber type. Though site maintenance is not

as critical as for the bottomland sites, site specific harvesting restrictions are recommended. The forest management regime which will ensure species composition and grade is selection harvest.

Current Problems

Most forest resource problems are related to owner goals and/or lack of knowledge of forest management at the time of land treatment or timber harvesting. The typical "driving force" for cutting timber is the need for money. This situation can be attributed to a "depression" in the farm or agricultural markets or general financial woes of landowners. Compounded by the typical "immediate need" situation, it is seldom that an owner sells timber more than once in a lifetime, and therefore, has little knowledge of the mechanics of the process.

Despite the efforts of foresters and availability of forestry assistance programs, the largest percentage of forest land treatment is done without consideration of the perpetuation of the forest or site condition. This fact leads to the major problems of environmentally disrupting harvesting methods and harvesting practices. (Harvesting methods or forest management techniques concern which trees are cut, i.e., selection, clearcut, patch cut, timber stand improvement, etc.; while harvesting practices are the mechanical methods of removal, i.e., rubber-tired skidder; utlization of buffer strips, skid trails, stream crossing, etc.).

The primary harvesting method of concern for the Corridor is use of the clearcut method. Clearcutting of all merchantable stems, especially in conjunction with poor harvesting practices, can lead to soil erosion; siltation of soil nutrients; loss of seed source from genetically superior trees of various species; loss of timber grade in the future stand through stump sprouts; lower quality species and reduced competition (yellow poplar is an exception); and loss of the "filtering" system of which standing trees are a component. Except where yellow poplar is predominant, these losses are seen for at minimum one decade.

The mechanical damage created by poor harvesting practices and the associated natural site degradation are viewed as the most critical problem.

The greatest losses occur when 1) harvesting is performed during wet seasons, 2) there are no buffer strips to stream bluffs or slopes greater than 10 percent, and 3) debris is left in streams and/or equipment is run directly across or through streams. These practices cause deep rutting, increased soil erosion and siltation, slope or bluff collapse, and blockages to waterways.

The final result of the created environmental problems can be the reduction or elimination of seedling establishment and survival, flooding, increased stream pollution and numerous other environmental problems.

Land conversion for residential construction and gravel pits are also considered as forest resource problems. The continued loss of the forest land base to other uses does not always create immediate adverse impacts; however, over time impacts of supply and demand problems will affect us all.

The immediate impacts of current residential construction in primarily the upland forests of the Corridor are loss of timber

grade from septic tank influences and heavy equipment usage; and slope/bluff erosion and instability.

The immediate concerns of gravel pits in woodland along the main corridor of the Murderkill River are threat of potential pollution from river bank erosion into the borrow pit and the inability to effectively and rapidly revegetate the area once the pit is abandoned.

Management Alternatives and Possible Solutions

1. The problems of environmentally damaging harvesting methods and practices can be reduced, if not eliminated, through timely forester site assessment and harvest planning, assuming owner dedication to use of such a plan. Forester planning includes use of selective harvesting and/or patch clearcutting in mature hardwood stands; and harvesting layout and sale contract restrictions including wet season restrictions, buffer zones (minimum 50 feet) along streams, skid trail layout, stream crossing limitations and others, as site conditions dictate.
2. The forest resource base and environmental concerns of residential construction, borrow pits and other forest land conversions can be minimized through use of stream bank buffer strips, site specific critical impact assessment prior to zoning changes, long-term land use planning, (such as low density planning for residential communities) and requirements for revitalization and revegetation of areas disrupted.
3. Site specific forester assessments for proposed land use changes are currently available through the state Forest Service. Generalized forestry guidelines can be developed (for distribution) which enumerate methods for minimizing adverse impacts of forestry practices and land use changes. Distribution through "currently in place" programs of cooperating agencies could help achieve owner acceptance.
4. Education and public relations seem to be one key element to success. Beyond this immediate need, it must again be recognized that in most cases the forests of Delaware are generally treated with monetary return in mind. Environmental protection measures and harvesting regulations are relatively costly. These costs are most always passed on to the owner. Perhaps effective financial incentives to woodland owners can be developed through the combined experience of agencies involved in the Corridor project.
5. Many of the needed options for managing woodland for financial return while ensuring future forests and reducing environmental impacts are currently available. Increased knowledge of these management options by landowners is greatly needed. Though incentives are also perceived to be needed, future investigation into what methods would achieve the desired results should be undertaken.

HISTORICAL AND CULTURAL RESOURCES

Alice Guerrant, Historical Archaeologist,
Historical and Cultural

Prehistoric Resources

The Murderkill drainage is one of the best-known areas in Delaware for prehistoric archaeological sites, having been extensively surveyed and studied by the University of Delaware Center for Archaeological Research under a grant from the Delaware Bureau of Archaeology and Historic Preservation. The area was included in the test cases used for developing a general model of site locations in such environments. This summary is taken from articles discussing this research in the Fall, 1983, issue of The Bulletin of the Archaeological Society of Delaware.

Although prehistoric settlement in Delaware began some 14,000 years ago, with the Paleo-Indian period, very few sites of that period are known in this area. At that time, much larger amounts of water were held in the polar icecaps than are held today, resulting in a dramatically different climate, landscape, and coastline than presently exists. Sea level was much lower, the mouth of the Delaware River was not yet inundated, and environmental zones were hence shifted eastward. Tundra-like conditions covered most of Delaware, and aboriginal subsistence was focused on hunting the giant fauna of the Pleistocene, such as mammoth and giant bison. The area's usefulness for Paleo-Indian populations consisted of "the poorly-drained game-attractive settings of the mid-peninsular drainage divide," and hence sites found are "small lithic scatters that indicate occasionally utilized procurement sites" (Custer and Galasso, p.7).

With the end of the Pleistocene, polar icecaps began to melt and worldwide sea level rise began. By about 6500 B.C., the climatic conditions more nearly approximated modern ones, and the hardwood forests that once covered Delaware had developed. The Pleistocene megafauna became extinct, and prehistoric cultures shifted to more intensive hunting and gathering techniques, with an increased reliance on plant materials. This time period, know as the Archaic (6500 B.C. - 3000 B.C.) also left few traces in the Murderkill area. However, enough sites were found to postulate a different settlement pattern and use of the area than during the previous period. "Some kind of macro-band base camp focal point exists in the Archaic settlement systems which also include a variety of micro-band base camp/large procurement sites (Custer and Galasso, p. 11).

The end of the Archaic period is marked by the development of pottery, and an increase in the number of sites, which have been interpreted generally to mean the development of increasing plant use leading to horticulture, with a concomitant rise in population density and a shift in the settlement pattern to a semi-sedentary existence. These cultural changes define the Woodland period (3,000 B.C. to A.D. 1,600). In the mid-Atlantic

region, and particularly for Delaware, this period has been divided into two parts.

The earlier part, Woodland I (3,000 B.C. to A.D. 1,000) has left the largest number of sites in the Murderkill area. Nearly all are located in floodplain settings, often along the major drainages or at stream confluences. These indicate "a shift of settlement pattern foci to major drainage floodplain settings as part of an adaptive response to the warm, dry climatic conditions of the mid-postglacial xerothermic" (Custer and Galasso, p. 11). In addition, large numbers of procurement sites in the interior of the drainage have been found, which "probably represent hunting stations at game-attractive locales" (Custer and Galasso, p. 12).

It was during this period that the greatest complexity of prehistoric social organization has been noted in the archaeological remains. Elaborate ceremonial sites and other evidence, in the form of exotic artifacts, have been found that point to a social system that participated in a trade network ranging from present-day upstate New York and the Ohio River Valley to the Dakotas. In the Murderkill River drainage, this is exemplified by the Island Field Site, a c. 740 A.D. cemetery, now an archaeological museum and research facility operated by the State of Delaware.

By around A.D. 1000, these extensive trade networks had apparently collapsed. This marks the beginning of the Woodland II period (A.D. 1000 - A.D. 1600). Despite the disappearance of exotic materials and the lack of evidence for a hierarchiacal social structure from sites of this period, the archaeological remains point to many continuities in lifestyle and economic organization, including the same general site locations.

With the coming of European settlers the Contact Period began. During the hundred years or so that recognizable Indian cultures were able to retain their identity on the Delmarva peninsula, white settlement steadily encroached on their lands, and rapid acculturation to white lifestyle and economy drained their traditional ways. Between 1730 and 1750 most of the remaining Indians in Delaware moved as a group to the western New York and Pennsylvania areas, joining a stream of different Indian groups being pushed westward, gradually losing their individual tribal identities and merging with the Delawares, Iroquois, and other larger groups. No sites from the Contact Period are known in the Murderkill drainage, and very few have been identified for the entire state.

At present, about 125 sites are recorded in the Murderkill River drainage. Many of these were used over and over again throughout the prehistoric period, with the great majority of these sites dating to the Woodland I and II periods. Few of these sites have been even minimally tested although several broad area surveys have been performed. Only the Island Field Site has been extensively excavated. Publications with more information on the archaeological work in this area are available at the Island Field Museum, the Bureau of Archaeology and Historical Preservation, and the Division of Natural Resources and Environmental Control. Besides publications, the Island

Field Museum presents a slide talk and many exhibits on prehistoric life and artifacts. In addition, Killens Pond State Park now has a brochure and markers for a self-guided tour along a hiking trail that interprets recently discovered prehistoric sites.

Historic Period Resources

The Murderkill River Watershed consists of a large section of South Murderkill Hundred, with small portions of North Murderkill, Milford, and Mispillion Hundreds. The Hundred is an early English sub-county unit once used in Delaware as a voting and census district and still used to record land transactions. The eastern portion of the watershed, especially Murderkill Neck, includes some of the earliest land patents in Kent County, dating to the 1680s. This area, since the time of its earliest European settlement, has had primarily an agricultural economy, focused on grains in the colonial period, and switching to fruits and vegetables after the Revolutionary War. The 17th- and 18th-century history of this area revolves around the evolution of the landscape from a forested, natural wilderness to a cultural landscape molded by man, with defined fields, clusters of buildings, and road networks.

Until the early part of the 19th century, forestry products played a large part in the area's economy. However, these were fairly rapidly depleted, as more and more land was cleared for farming. Eighteenth century farming methods and the greatly increased erosion caused by land clearing led to soil depletion by the late 18th century. Farmers became more and more concerned about their land's lessening productivity and began efforts towards replenishing the fertility of the soil. In this, they were joining a nationwide movement known as scientific farming. Among the tenents of this movement was the diversification and rotation of crops, with the increasing use of clover and manure. In addition, farmers into the 20th century obtained oyster shells from the oystermen at Bowers Beach, and burned the shells for lime for fertilizer.

The leading example of the areas progressive 19th century farmers was Jehu Reed. He experimented extensively with fertilizers and crops, developing from a large nursery business his own vast acres of fruit trees. He is credited with introducing large scale peach production into Kent County, beginning the establishment of his orchards about 1830. For some time he maintained his own line of fast sailing vessels to take his peaches speedily to market. The Jehu Reed House a true "peach mansion" still stands at Little Heaven as a monument to Reed's wealth and taste.

Even the industrial efforts in this area were tied to agricultural pursuits. The earliest of course, were water-powered grist and saw mills, which quickly multiplied along the Murderkill and its tributaries, above the head of navigation. Because of the area's low relief, impoundments were necessary. Several of these former mill ponds and dams still exist on the waterway, including McGinnis, Andrews, Coursey, Killens, and McColley ponds. Today these ponds are primarily for recreational

use and hence are generally larger than they were historicsally. Their names memorialize a few of the many millers who operated along the Murderkill in the past. Although no longer extant, the site of the mill and miller's house at Killens Pond was located during an archaeological survey but has not been excavated.

During the 19th century some industries were established in the few towns that developed in the area, but as was the case with the 18th century milling industry, these manufacturies were all connected with agricultural production or the processing of the area's raw materials. Both steam and watermills to saw timber were important, especially for sawing shiptimber both for export and for the developing local shipyard in Frederica. Other important industries were canneries, fertilizer plants, a plow manufactory, brush factories, basket factories, carriage builders, and nurseries. These were concentrated in Frederica, which developed around the major landing on the Murderkill, and the railroad towns of Viola, Felton, and Harrington; other important commercial interests were also geared to the farming community such as dealers in farm machinery and hardware, and blacksmiths specializing in repairs rather than new products. Few of the buildings that once housed these integral parts of the past's agricultural economy now survive.

One of the major historical events in the area occurred in 1856, with the opening of the railroad through the central part of Delaware. This created major changes in the landscape, with the rapid creation of new towns around the railway stops, including Viola, Felton, and Harrington. Older towns such as Frederica, were economically threatened, and often experienced a slowing or reversal of their growth. The market in perishable fruits and vegetables was given a tremendous boost, especially with the development of refrigerated boxcars, using ice to cool their contents. The railroad was of central importance to the Murderkill area until the invention and development of truck transport in the 20th century. Reminders of this era can be seen in the railroad stations still standing in Felton and Harrington.

Aside from the area's general contributions to Delaware's economic and social history, one nationally significant historical movement began here, the development of Methodism as a separate religion. Barratt's Chapel, built in 1780, is known as the Cradle of Methodism for the part this structure played in 1784 in the decision to cut American Methodism's ties with the English Episcopal Church. In addition, the Barratt House, where further discussions were held between the conference leaders and Francis Asbury, also still stands nearby. Barratt's Chapel and Museum are open to the public for a fee, and offer an excellent opportunity to learn about the beginnings of one of the major Protestant churches in the United States today.

Management Options

1. Cultural resources - the physical remains of our past - are non-renewable; once destroyed, they are gone forever. Planning to incorporate the preservation of the past as we move into the future is essential. The Bureau of Archaeology

and Historical Preservation is now engaged in producing a plan for cultural resources throughout the state. This plan identifies primary research orientations and sets goals and priorities for recording and preserving historically significant properties across the state.

2. Several things can be done by both the public and the private sectors to protect cultural resources. For archaeological sites, the preferred alternative is preservation in place. Excavation is extremely expensive and time-consuming, and it is desirable to have a "bank" of preserved sites that could be investigated in the future with new techniques and research goals. Sites can be preserved by avoiding ground disturbing or erosional activities in their vicinity such as tree removal, deep plowing, construction work, or dirt-biking. Ways to accomplish this sort of site preservation include the Natural Areas program administered by DNREC, or zoning restrictions or conditions in site areas.
3. On state-owned lands, this type of protection is insured by the Antiquities Act, which forbids any kind of site excavation or disturbance, except for academic research by qualified professionals under a permit from the Director of Historical and Cultural Affairs. In order to avoid accidental damage during normal maintenance or facilities expansions, DNREC has begun a program of archaeological surveys of each of its parks. One of the first parks for which this has been done is Killens Pond. This program is designed to delineate site areas and to produce a management plan to guide future park activities and protect culturally sensitive areas. These surveys are partially funded by the Historic Preservation Fund of the National Park Service, administered in Delaware by the Bureau of Archaeology and Historic Preservation.
4. Preservation of the historic landscape is also of concern in this area, which has one of the best preserved cultural landscapes in the state. Protection of agricultural lands and open spaces accords well with historic preservation goals for this area. In addition, the preservation of the built environment, both rural and town, is of considerable importance in maintaining a feeling of the past. The Bureau of Archaeology and Historic Preservation performs surveys to identify and nominate historically significant buildings to the National Register of Historic Places. This action recognizes structures worthy of preservation and makes its owners eligible for certain tax benefits. While it gives a measure of protection from federal actions, listing in the National Register does not place any restrictions or demands on owners of listed properties. For private owners who are interested in retaining the historic appearance of their properties, the Bureau provides free technical advice on the best methods and approaches for doing so.

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NATURAL HERITAGE

Charles R. Vickers, Chief, Natural Heritage
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The Natural Heritage Programs of the Division of Parks and Recreation are directed toward preserving Delaware's biological and ecological diversity. Two major programs involving the Murderkill River Corridor are natural areas preservation and rare plant conservation.

The Office of Nature Preserves within DNREC is legislatively mandated under the 1978 Natural Areas Preservation System Act to administer a statewide system of nature preserves and natural areas. These lands contain unique or significant examples of Delaware's diverse natural heritage: unspoiled wetlands, old growth forests, rare plant and animal communities, and geological or archaeological sites. These natural landscapes provide endangered species habitats, scientific research sites, reservoirs of native ecosystems, critical areas benefitting the environment, and buffers against modern-day pressures.

Protection of natural areas is encouraged by a voluntary - three step process: (1) inventory - locate the most significant sites;
(2) registration - recognition by the state and landowner of the significance of the area and a good-faith agreement to protect it; and (3) dedication - permanent legal restriction placed on the area through a conservation easement or articles of dedication. Once a natural area is dedicated, it is a nature preserve.

The Murderkill River Corridor contains three areas listed on the statewide Natural Areas Inventory. One is the Island Field Site, a prehistoric occupation and burial site. Part of a 1200-year-old cemetery is preserved at the Island Field Museum, with five acres owned by the State of Delaware and managed by the Division of Historical and Cultural Affairs. The surrounding land is in private ownership and efforts should be directed toward long-term preservation of more of the site.

The second area is the Miocene Beds at Coursey Pond. This exposed fossil outcrop is on both sides of the tumblehole below the spillway. This convenient location makes it ideal for teaching purposes and lends itself to interpretation.

The third portion of the Murderkill River Corridor on the Natural Areas Inventory is the river and adjacent woodlands and wetlands from Frederica to Coursey Pond and down Brown's Branch to McColley Pond. This large expanse of undeveloped waterway and wooded swamp is important for its wildlife habitat, wetland, recreation, and open space values. The area is diverse in its vegetative composition. Low salinity areas have big cordgrass and high-tide bush. Freshwater marshes are dominated by cattails and marsh mallow. The wooded swamp areas are dominated by red maple, black gum, green ash, and bayberry. Some areas contain steep banks and bluffs with oaks, tuplip trees, scrub pines, dogwoods and American beech trees.

Two sections of this corridor have been dedicated as nature preserves. This means these sites have legal restriction attached to the deeds to permanently protect the natural resources. In January 1985, seventy-two acres were donated to the Office of Nature Preserves for the purpose of setting up a nature preserve. This site is known as the Burton-Derrickson Tract. In December 1985, fifty-five acres were donated by another landowner. This site is known as the Hopkins-Trice Tract.

The natural areas program is voluntary. Our efforts succeed only with the cooperation of the landowner. Efforts are underway to contact area landowners about protecting the natural heritage values of their property. Several options are available. Landowners can register the portion of their property within the defined natural area with the Office of Nature Preserves. Although not legally binding, registration is recognition by the state and landowner of the significance of the area and a good-faith agreement to protect it.

Another option for protection is dedication. There are two different ways of dedicating land. One option is the landowner retains the deed to the land and sets up a conservation easement. Legal restrictions for protection of the natural values of the site are attached to the deed. The second option for dedication is a donation or gift of the land. In this case the landowner transfers ownership to the Office of Nature Preserves and deed restrictions are applied to the site. For both options, conservation easement or donation, some type of economic incentive is afforded the landowner. Depending on the circumstances, property, income and inheritance taxes may be reduced.

A second major natural heritage program is Delaware's Rare Plant Conservation Program. Of the more than 1,700 native vascular plants in Delaware more than 400, or about 25%, are rare (species with three or fewer populations statewide). With the potential for such loss of diversity, the need to increase efforts to protect and preserve Delaware's flora is apparent.

The Murderkill River Corridor needs to be inventoried for rare plant species. This survey could begin on public lands within the corridor and then expand to private lands. With the vast majority of Delaware's rare species being wetlands-associated plants, there is the possibility of some of these species being in the corridor.

The preservation of biological and ecological diversity is a far-reaching responsibility involving a well-defined and coordinated effort on the part of many groups - public and private. Natural areas and rare plants are frequently lost as a result of public and private actions. These losses may be the result of inadequate information, economic pressures, carelessness, or indifference. The Office of Nature Preserves is in the process of developing a natural areas directory to help avoid such losses by informing public agencies, private conservation groups and interested individuals about natural areas in Delaware and about legal obligations when considering public projects and making land use decisions.

Management Options

1. Contact landowners in the defined natural area to encourage registration and dedication of land.
2. Conduct a rare plant survey, beginning on public land.
3. Distribute a Natural Areas Directory to appropriate public and private organization.

The Murderkill River Corridor Study emphasizes the natural resource values of this area. It is hoped that this will provide further impetus for protection of the natural heritage of this undisturbed waterway.

RECREATION

Susan M. LaPorte, Division Planner, Division of
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Within the study area, Killens Pond State Park is the largest recreation facility. It covers 581 acres, including the 66 acre pond. The park features a swimming pool and recreation complex with ballfields, picnic area and a playground. Picnic pavilions for group picnicking, small fishing piers, a 59-site family campground, primitive camping areas, and trails are also found at the park. A variety of water craft can be rented at the pond.

The Killens Pond State Park Master Plan, which was completed in 1970, recommends the establishment of most of the park's existing facilities, however it suggests facilities in greater numbers (listed below) and a much larger land base. The land base recommended had boundaries extending from Route 13 east to County Road 15, south to an area below McColley Pond. (See attached map). This land base covers 3260 acres and encompassed Killen, Coursey and McColley Ponds.

The 1984 Delaware Outdoors, the state comprehensive outdoor recreation plan (SCORP), identifies recreation facilities needed by the state's citizenry. In Kent County the following facilities are recommended for future development: bicycle trails, swimming pools, swimming - natural site, tennis courts, saltwater fishing, football/soccer fields, campgrounds, and golf courses. These represent, in order of priority, the highest demand for recreation in the county.

The Killens Pond Master Plan recommends three swimming pools, a driving range and 18 hole golf course, four camping areas, three boat launch sites, a nature center, a riding stable, numerous picnic areas, and an extensive trail system including trails for nature/hiking, horseback riding, bicycling and canoeing. Most of these facilities fall within the SCORP findings.

Management Options

1. In order for Killens Pond State Park to include facilities recommended in both the Master Plan and the SCORP, more land must be purchased. A land acquisition program would also protect sensitive areas. Land in this rural area is becoming developed around the ponds and in strips of single-family housing along roadways. Though this is a problem to conforming with the Master Plan, management options do exist.
2. Land acquisition of properties adjacent to the existing park should continue. The area downstream between Killen and Coursey ponds should be considered for purchase. This would expand the state park (in accordance with the Master Plan) and provide protection along the Murderkill River Corridor. Acquisitions could be made as far north as Route 384 and south to Route 426. Housing development around McColley Pond

precludes acquisitions; however, purchases could be targeted below the spillway on Browns Branch, east of Route 388. Additionally, the river corridor west of the state park to Route 13 should be acquired.

3. In addition to fee-simple acquisition, conservation easements should be employed along the river corridor to assure protection. Kent County should be encouraged to cooperate in river corridor protection through appropriate zoning classification in the county's Comprehensive Land Use Plan. The county also should be encouraged to provide more park and recreation areas which could be located within the study area.

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WATER QUALITY

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DNREC

Background

The Murderkill River basin is comprised of about 68,000 acres in southern Kent County. The river has a saline tidal main stem of about 11 miles, and three major tributary streams, each of about 10 miles length. These tributaries are Brown's Branch (which rises near Harrington), the upper Murderkill (which rises southwest of Felton), and the Spring Creek system (including Double Run which rises near Woodside, Hudson Branch which rises near Viola, and Pratt Branch which rises near Felton). The river flows toward the northeast and discharges to Delaware Bay at Bowers. Agriculture is the predominant land use in the upper reaches of the basin, with forest and residential areas of secondary importance. State-owned areas that provide access to water-based recreation include McGinnis Pond, Killen Pond State Park, Andrews Pond, Coursey Pond and McColley Pond.

Monitoring

The state has 17 routine water monitoring stations in the Murderkill River basin. These stations are shown on the map on the following page (numbers 3, 5, and 7 are inactive). Approximately 35 miles are assessed.

Standards and Designated Uses

Murderkill River water quality is governed by the general saltwater and freshwater criteria. The designated protected uses for the river include industrial water supply, primary contact recreation in freshwater areas, secondary contact recreation, propagation of fish, aquatic life and wildlife, and agricultural water supply in freshwater areas. The river is rated 17th (out of 36 basins) on DNREC's basin priority list.

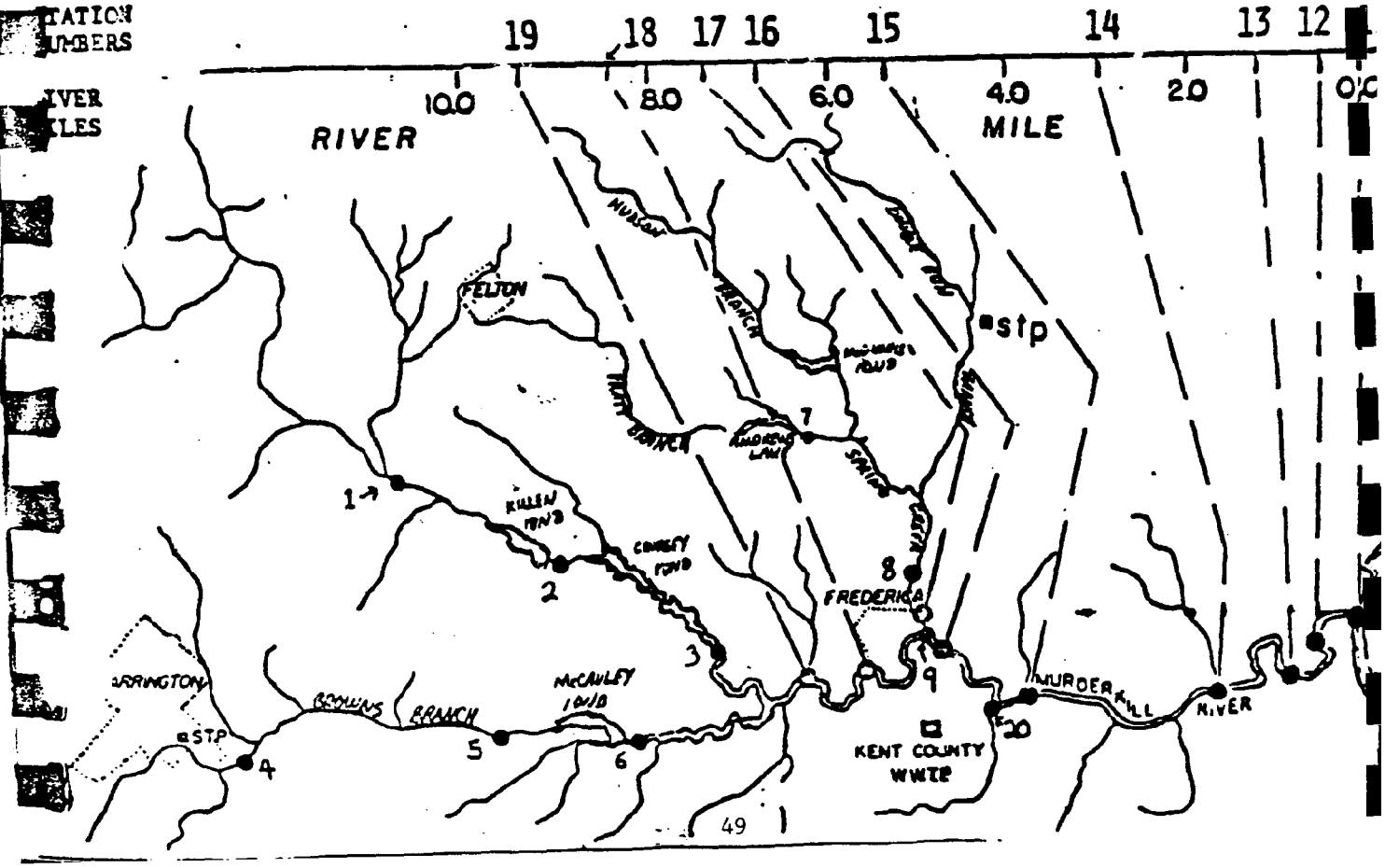
Historical Water Quality

The 1984 Water Quality Inventory described the river as having water quality which cannot fully support some designated uses. Problems were most common in the saline tidal area, where seasonally low dissolved oxygen levels affected the propagation of fish and aquatic life use. The freshwater areas had generally good water quality. The Federal Clean Water Act's goal of achieving waters of "fishable-swimmable" quality appeared to be met throughout the basin, although parts of the saline tidal area may not have had full attainment. Trends toward lower bacteria and nutrient levels were noted in the freshwater areas, while dissolved oxygen levels appeared to be heading lower in the saline tidal areas. Causes of the observed problems were rank-ordered as natural (wetlands runoff), upland runoff, and point source discharges.

AMBIENT SAMPLING STATIONS

MURDERKILL RIVER (23.14 miles from Cape Henlopen)

	LOCATION DESCRIPTION	RIVER MILES	STATION/STORET NUMBERS
1.	U.S. Rt. 13, below Felton	17.12	1-206011
2.	Rd. 384, Killen Pond	14.87	2-206021
3.	Rd. 35 bridge	12.29	3-206031
4.	Del. Rt. 14, Browns Branch	10.72/7.39	4-206041
5.	Rd. 384 bridge, Browns Branch	10.72/4.62	5-206051
6.	Rd. 388 bridge, McColley Pond	10.72/2.50	6-206061
7.	Rd. 380, Andrews	7.46/3.55/0.45	7-206071
8.	Del. Rt. 12, Spring Creek	7.46/0.22	8-206081
9.	Frederica By-Pass bridge, U.S. Rt. 113	7.20	9-206091
11.	Zero Mile from Mouth (Boat)	0.00	11-206111
12.	0.46 Mile from Mouth (Boat)	0.46	12-206121
13.	1.25 Miles from Mouth (Boat)	1.25	13-206131
14.	3.25 Miles from Mouth (Boat)	3.25	14-206141
15.	5.39 Miles from Mouth (Boat)	5.39	15-206151
16.	7.11 Miles from Mouth (Boat)	7.11	16-206161
17.	7.14 Miles from Mouth, Spring Creek conf. (Boat)	7.14	17-206171
18.	8.32 Miles from Mouth (Boat)	8.32	18-206181
19.	9.64 Miles from Mouth (Boat)	9.64	19-206191
20.	5.71 Miles from Mouth (Boat)	5.71	20-206231



Recent Water Quality: July 1983 to June 1985

Analysis of water quality data has been accomplished using the EPA-STORET computer system programs STAND and MEAN (for further details, refer to the Introduction). Examination of the data indicates potential problems in the saltwater area. Most parts of this area have low dissolved oxygen levels during the summer months, with the lowest levels (at times near 1.0 mg/L) noted between river miles 3 and 9, above Frederica. High fecal coliform bacteria levels are also seen throughout this same stretch of river, in Spring Creek, and in the headwaters of the river near Felton. Low pH and alkalinity values are common to the freshwater segments of Brown's Branch and the upper Murderkill. Evidence of a possible phenols problem in the saltwater area is also highlighted. These findings suggest that some designated uses may not be fully supported.

A review of monitoring data reveals some interesting patterns in nutrient distribution. The freshwater areas generally have moderate to high average total nitrogen (3.2 to 4.4 mg/L) and low total phosphorus (0.10-0.14 mg/L) concentrations. The saltwater areas typically have lower total nitrogen (most values about 2.6 mg/L average), but maintain much high total phosphorus levels (generally near 0.45 mg/L). Low levels of BOD_5 are common in the freshwater area above Killens Pond and at McColley Pond, and in the saltwater area between river miles 0.0 and 6.0. In these areas, the majority of measurements fall below the minimum reported value of 2.4 mg/L.

Discussion

The above water quality information seems to show potential for impact on beneficial uses in the saltwater section of the river. The fish and aquatic life use may be stressed due to the seasonally depressed dissolved oxygen levels at mid-basin. The low BOD_5 values seen in most of this segment seem to suggest that the water is not carrying high levels of organic wastes. Rather, the low dissolved oxygen may be caused by natural benthic demand or by nearly anoxic water draining from the wetland margins. Primary contact recreation use may be affected by the excessive bacteria levels found. The elevated concentrations of phenols may impact the edibility of fish tissue (taste and odor effects). However, it is believed that the phenol results may be spurious due to interferences with the laboratory test by natural components of the river water. The Clean Water Act's "fishable-swimmable" goal is rated "generally attained" because the possible impacts outlined above appear to be caused primarily by natural effects.

Comparison of the 1984 and current water quality evaluations shows some possible trends. The river in the vicinity of Frederica appears to have declining dissolved oxygen, and higher total phosphorus and fecal coliform levels. Brown's Branch seems to support improving dissolved oxygen concentrations. This improvement may be the result of the recent upgrading of the Harrington sewage treatment plant. The Murderkill River estuary appears to be phosphorus-rich in comparison with other Delaware estuaries. The excess phosphorus may have the Kent County sewage treatment plant near Frederica as its source.

A biological investigation of the river near the Kent County Regional STP discharge was performed in July, 1985. The purpose of this work was to determine what, if any, impacts the Kent County discharge has on the river biota. Macroinvertebrates were sampled at three location (two near the discharge and on "control") using a Petite Ponar and epibenthic skid dredge. The results showed high densities of tolerant organisms nearest the discharge, a dense but more diverse community at the downstream location, and a low density, fairly diverse community at the control station. The report concluded that the discharge exerts multiple stresses on aquatic life (as evidenced by poor diversity and immense standing crop), but this influence decreased rapidly downstream of the outfall. The literature suggests that freshwater macroinvertebrates cannot survive salinities above 0.5%; this fact may in part explain the results found.

There are three permitted point source discharges in the Murderkill River basin. These are: Kent County Regional STP, Harrington STP, and Southwood Acres STP. The total wastewater flow from these facilities (about 97% of which is from Kent County) is 15.516 MGD, and contains about 3820 lb/day each of BOD_5 and TSS.

Looking Ahead

The Murderkill River has been chosen as the site of a pilot project under the Delaware "Stream Watch" program. The objective of this program is to encourage citizen involvement in the protection of stream water quality. The pilot project began in the spring of 1986.

Management of animal manure to prevent degradation of the surface and groundwaters of the state is being emphasized by DNEC, the Delaware Cooperative Extension Service, the Soil Conservation Service, and Conservation Districts.

Management Options

1. Work with all agencies and the Kent Conservation District to encourage the storage of animal waste manure under cover until the proper time to apply it on the land.
2. Encourage the adoption of the "MANURE" program to promote balanced use and management of manure, fertilizers, etc. to protect and improve water quality.
3. Stress protection of stream quality through the Delaware "Stream Watch" program.

REFERENCES

Delaware Nature Education Society. Delaware Stream Watch Guide. July 1986.

Department of Natural Resources and Environmental Control, Division of Water Resources. 1986 Delaware Water Quality Inventory.

WETLANDS

Bennett N. Anderson, Environmental Scientist, Water Resources Division, Wetlands and Underwater Lands Branch, DNREC.

Introduction

From a resource point of view, the Murderkill River drainage basin has without a doubt the last of the highest quality untouched natural resources left in the state. The flora and fauna found in the river and its surrounding wetlands thrive in a diversity of natural habitats from tidal saline at the river's mouth to fresh at its headwaters. The river's mostly unbroken natural corridors allow free movement of wildlife along its watercourse. Few areas of the state can boast of such a natural setting and because of this, its recreational values and uses are highly regarded.

The wetlands comprising part of the Murderkill River watershed are a limited and highly valued resource. The support that wetlands provide to wildlife and water quality has been widely documented over the years. For these reasons, any proposed development having primary or secondary impact upon wetlands should be given close scrutiny and proper planning.

Background Definition

There is dual jurisdiction over wetlands in the Murderkill watershed. The State of Delaware claims jurisdiction through Title 7, Chapter 66 - The Wetlands Act of 1973 - over tidal wetlands within the state. These are defined as "...those lands above the mean low land subject to tidal action ... which are capable of growing a wide variety of wetland plants." Federal jurisdiction covers a broader range of wetland habitats through Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1977 which define wetlands as "...those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Wetland Classification System

Classification of wetlands is based on three factors: vegetation, soils and hydrology. The classification system itself was devised and adopted by the U.S. Fish and Wildlife Service in 1979 and has been widely accepted and used by federal, state, and local agencies, university scientists and private industry for identifying and classifying wetlands. The classification system is hierarchical, or vertical, in nature, proceeding from general to specific. The highest level and most general is the System level consisting of five units: marine (open ocean), estuarine (saline and brackish waters and marshes), riverine (rivers and streams), lacustrine (lakes and ponds), and paulustrine (shallow marshes, bogs, swamps and shallow ponds). The next lower tier is the sub-system which describes the tidal regime for Marine and Estuarine

systems, the water depth for laustrine systems and water flow in the riverine system. Next the class level describes the general appearance of the wetland in terms of dominant vegetative cover (e.g. forested, shrub-scrub, emergent grasses). The class is further subdivided into sub-class to define the type of substrate if cover is less than 30% vegetated (e.g. bedrock, rubble, mud, sand or organic) or if more than 30% vegetated describing the dominance type of vegetation (e.g. broad-leaved deciduous, needle-leaved evergreen in the community). The sub-class is then followed by four types of specific modifens: (1) water regime, (2) water chemistry, (3) soil and (4) special. While it may sound somewhat complicated, upon examination, it is logical, straight forward and very useful.

Wetlands Inventory

In 1985, the U.S. Fish and Wildlife Service in conjunction with DNREC completed a wetlands inventory in Delaware to provide government administrators, private industry and others with improved information for project planning and impact evaluation and for making land-use decisions. This inventory identifies the current status of Delaware's wetlands and serve as the base from which future changes can be determined. It is available in a joint publication by the Fish and Wildlife Servive and DNREC titled Wetlands of Delaware. Much of the inventory data is still being analyzed for further application.

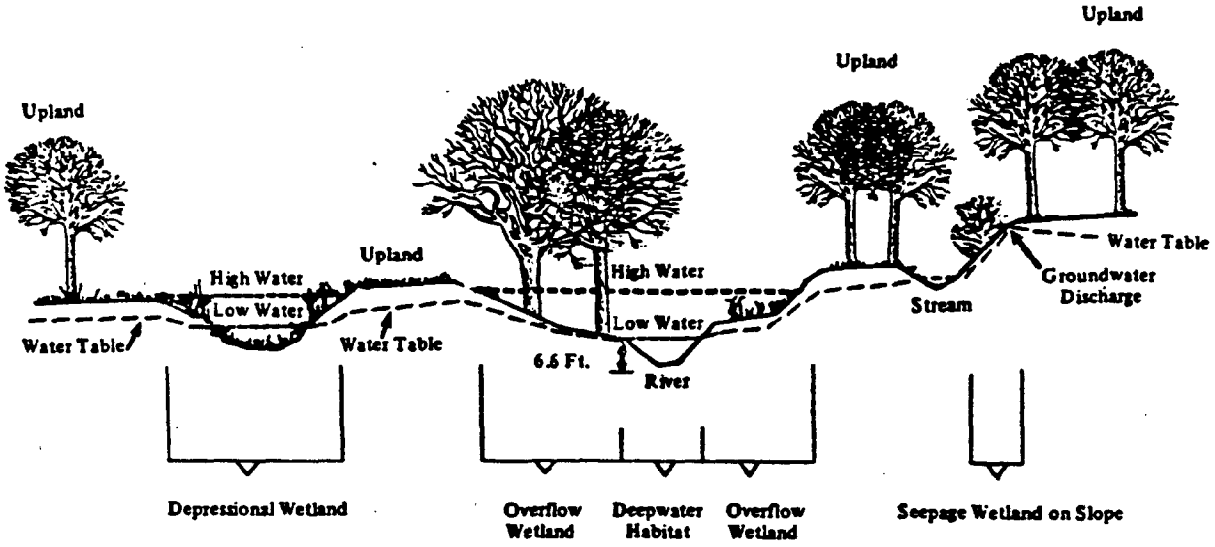


Figure 1 Schematic diagram showing wetlands, deepwater habitats, and uplands on the landscape. Note differences in wetlands due to hydrology and topographic position.

The Three Parameter Approach

In defining wetlands from an ecological standpoint, emphasis is upon the three key attributes of wetlands:

1. hydrology - the degree of flooding or soil saturation
2. wetland vegetation - hydrophytes
3. hydric soils - undrained, saturated, anaerobic soils supporting hydrophytes.

All areas considered wetland must have enough water sometime during the growing season to stress plants and animals not adapted for life in water or saturated soils. Most wetlands have hydrophytes and hydric soil present. The Soil Conservation Service has prepared this list of the hydric soils of Kent County:

Bayboro	Elkton
Fallsington	Johnston
Othello	Plummer
Pocomoke	Swamp
Tidal Marsh	Mixed Alluvial Land

The Fish and Wildlife Service has produced a very extensive list of Delaware's wetland plants (hydrophytes) which can be found in the appendix to **Wetland of Delaware**. Particular attention should be paid to the reference to flooding or soil saturation during the growing season. When soils are covered by water or saturated to the soil surface, free oxygen is not available to plant roots. During the growing season, most plants must have access to free oxygen for respiration and growth; flooding at this time would have serious implications for the growth and survival of most plants. In a wetlands situation, plants must be adapted to cope with these stressful conditions. If, however, flooding only occurs in winter when the plants are dormant, there is little or no effect on them.

Wetland Values - Introduction

Delaware's wetlands have a long history of use for hunting, trapping, fishing, timber, and livestock grazing. These uses tend to preserve wetlands integrity and resources and thus will continue to provide well into future generations. However, many other of man's activities run counter to wetland preservation and continuance. Activities such as drainage for agriculture and silviculture and filling for industrial or residential development result in a conversion of wetlands and a subsequent loss of those wetlands functions and values. To date only minor conversions of wetlands have occurred in the corridor.

Wetlands in their natural state provide a wealth of benefits and values to society. These benefits can be divided into three basic categories: (1) fish and wildlife values, (2) environmental quality values, and (3) socio-economic values.

Table 1. List of Major Wetland Values

Fish and Wildlife Values	Socio-Economic Values
-Fish and shellfish habitat	-Flood control
-Waterfowl and other bird habitat	-Wave damage protection
-Furbearer and other wildlife habitat	-Erosion control
	-Ground-water recharge
	-Water supply
	-Timber and other natural products
Environmental Quality Values	-Energy source (peat)
	-Livestock grazing
-Water quality maintenance	-Fish and shellfishing
-pollution filter	-Hunting and trapping
-sediment removal	-recreation
-oxygen production	-aesthetics
-nutrient recycling	-Education and scientific research
-chemical and nutrient	
-absorption	
-Aquatic productivity	
-Microclimate regulator	
-World climate (ozone layer)	

Fish and Wildlife Values

Fish and wildlife utilize wetlands in a variety of ways. Some animals are totally wetland-dependent, spending entire lives in wetlands. Others use wetlands only for specific reasons, such as reproduction and nursery grounds, feeding, and resting and staging areas during migration. Many upland animals utilize wetlands for protective cover and to obtain drinking water, especially important during severe droughts. Wetlands are also essential for survival of numerous threatened or endangered species of animals and plants.

Environmental Quality Values

Besides providing homes for fish and wildlife, wetlands play a less conspicuous but nonetheless important, role in maintaining high environmental quality, especially for aquatic habitats. They do this in a variety of ways, including purifying natural waters by removing nutrients, chemical and organic pollutants, and sediment and producing food which supports aquatic life.

Water Quality Improvement

Wetlands help maintain good water quality or improve degraded waters in several ways: (1) nutrient removal and retention, (2) processing chemical and organic wastes, and (3) reducing sediment load of the water. Wetlands are particularly good water filters because of their location between land and water. Thus they can both intercept runoff from land before it reaches the water and help filter nutrients, wastes, and sediment from flooding waters. Clean waters are important to people as well as to fish and wildlife.

Wetlands remove nutrients, especially nitrogen and phosphorus, from flooding waters for plant growth and help prevent eutrophication or overenrichment of natural waters. Freshwater wetlands are important in reducing nutrient and heavy metal loading from urban runoff. It is, however, possible to overload a wetland system (exceed its carrying capacity) and thereby reduce its ability to perform this function. Conversely, a wetland system that is functioning in dynamic equilibrium at its maximum carrying capacity will fail if any portion of its filtering system is altered or stressed by draining or filling in of the wetland. This point has already been evidenced by the annual late summer choking of ponds by aquatic vegetation.

Sediment

Wetlands also play a valuable role in reducing turbidity of surface water runoff. This is especially important for aquatic life and for reducing siltation of ports, harbors, rivers, and reservoirs. Removal of sediment load is also valuable because sediments often transport absorbed nutrients, pesticides, heavy metals and other toxins which pollute our waters. Depressional wetlands should retain all of the sediment entering them. But this valuable process is not without cost to the wetlands themselves. The trapping of sediment fills in the wetlands which shortens their lifespan and resulting beneficial functions and values. It is therefore imperative that Best Management Practices (BMP's) be implemented for both agriculture and urban runoff areas adjacent to wetlands.

Creek banks of salt marshes typically support more productive vegetation than the marsh interior. Deposition of silt is accentuated at the water-marsh interface, where vegetation slows the velocity of water causing sediment to drop out of solution. In addition to improving water quality, this process adds nutrients to the creekside marsh which leads to higher plant productivity.

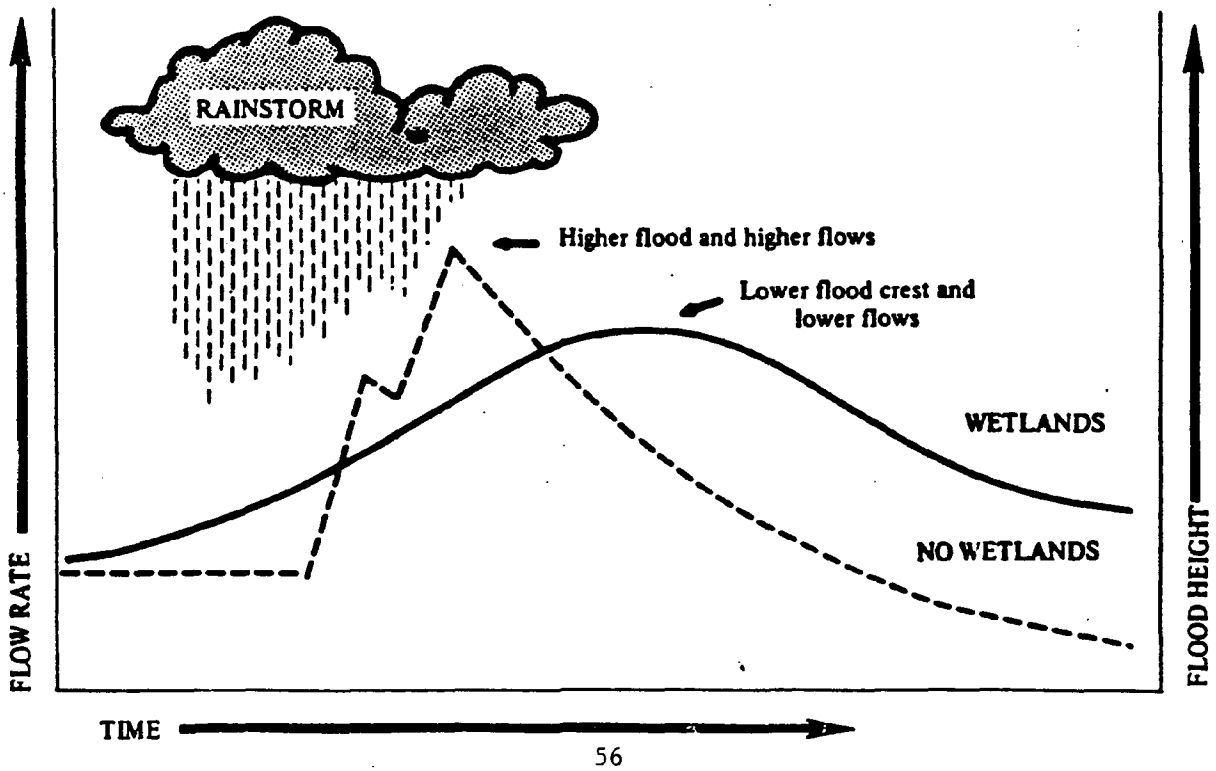


Figure 4. - Wetland values in reducing flood crests and flow rates after rainstorms (adapted from Kusler 1983).

Aquatic Productivity

Wetlands are among the most productive ecosystems in the world, rivaling our best cornfields. They are particularly efficient converters of solar energy. Through photosynthesis, plants convert sunlight into plant material or biomass and produce oxygen as a byproduct. Other material, such as organic matter, nutrients, heavy metals, and sediment are also captured by wetlands and either stored in the sediment or converted to biomass. This biomass serves as food for a multitude of animals, both aquatic and terrestrial. For example, many waterfowl depend heavily on seeds of marsh plants, especially during the winter, while muskrats eat cattail and bulrush tubers and young shoots.

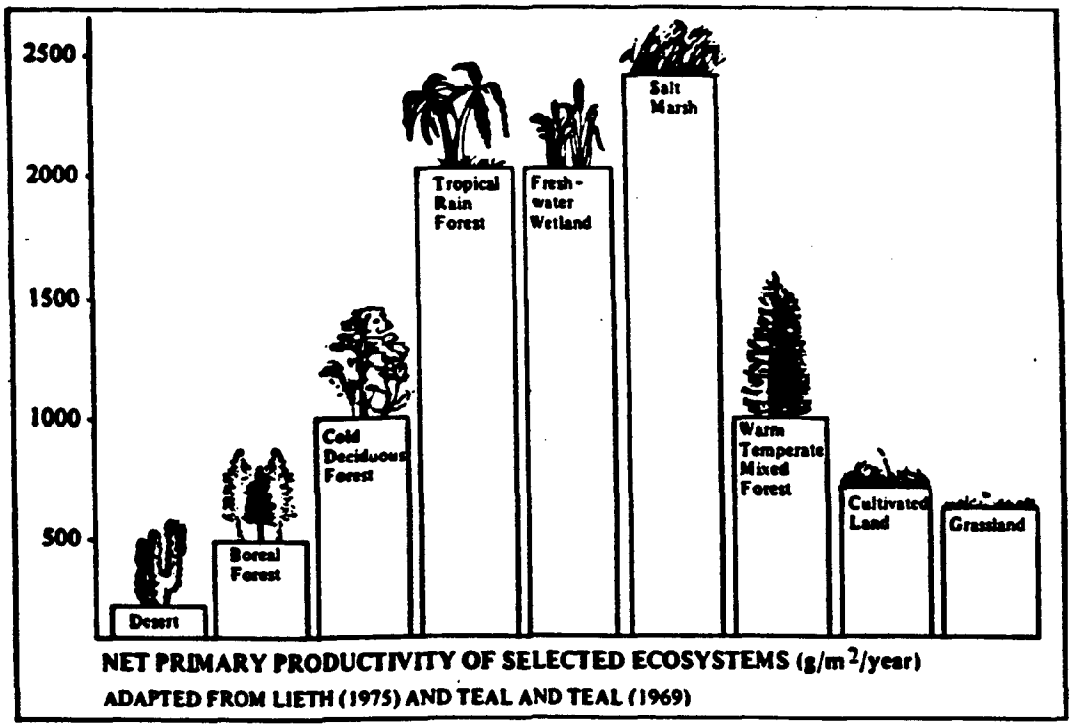


Figure 3 Relative productivity of wetland ecosystems in relation to other ecosystems (redrawn from Newton 1981). Salt marshes and freshwater wetlands are among the most productive ecosystems.

Although direct grazing of wetland plants is generally limited, their major food value is reached upon death when plants fragment to form "detritus". This detritus forms the base of an aquatic food web which supports high consumers, e.g., commercial fishes. This relationship is especially well-documented for coastal areas. Animals, like zooplankton, shrimp, snails, crabs, worms, killifish and mullet, eat "detritus" or graze upon bacteria, fungi, diatroms, and protozoa growing on its surfaces. Forage fishes (e.g. anchovies, sticklebacks, killifishes, and silversides) and grassfish are the primary food for commercial and recreational fishes, including bluefish, flounder, weakfish and white perch. A simplified food webs for Delaware estuaries is presented in Figure 4. Thus wetlands can be regarded as the farmlands of the aquatic

environment where great volumes of food are produced annually. The majority of non-marine aquatic animals also depend, either directly or indirectly, on this food source.

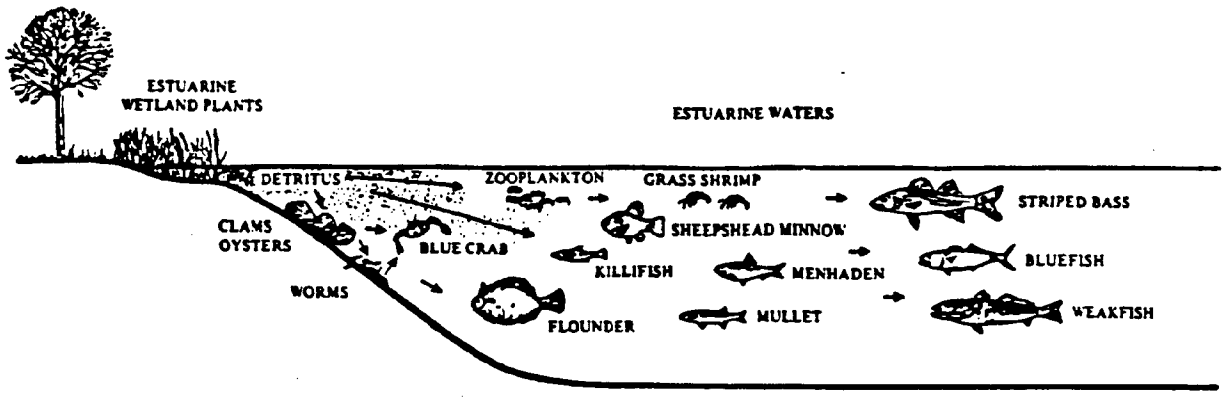


Figure 4 Simplified food pathways from estuarine wetland vegetation to commercial and recreational fishes of importance to people.

Socio-economic Value

The more tangible benefits of wetlands to mankind may be considered socio-economic. They include flood and storm damage protection, erosion control, water supply and ground water recharge, harvest of natural products, livestock grazing and recreation. Since these values provide either dollar savings or financial profit, they are more easily understood and appreciated by most people.

In their natural condition, wetlands serve to temporarily store flood waters, thereby protecting downstream property owners from flood damage. After all, such flooding has been the driving force in creating these wetlands to begin with. This flood storage function also helps to slow the velocity of water and lower wave heights, which reduces the water's erosive potential. Rather than having all flood waters flowing rapidly downstream and destroying private property and crops, wetlands slow the flood of water, store it for a period of time and slowly release stored waters downstream. This becomes increasingly important in urban areas, where development has increased the rate and volume of surface water runoff and the potential for food damage.

Besides reducing flood levels and potential damage, wetlands may buffer the land from storm damage. Salt marshes are considered important shoreline stabilizers due to their wave dampening effect. A fringe of salt marsh grass as narrow as eight feet can reduce wave energy by over 50%. Forested wetlands along lakes, ponds and large rivers will function similarly.

Summary - Values

Marshes, swamps and other wetlands are assets to society in their natural state. They provide numerous products for human use and consumption, protect private property and provide recreational and aesthetic appreciation opportunities. Destruction or

alteration of wetlands eliminates or minimizes their values. Drainage of wetlands, for example, eliminates all of the beneficial effects of the marsh on water quality and directly contributes to flood problems. While the wetland landowner can derive financial profit from some of the values mentioned, the general public receives the vast majority of wetland benefits through flood and storm damage control, erosion control, water quality improvements, fish and wildlife resources, and aesthetics. It is, therefore in the public's best interest to protect wetlands to preserve these values for themselves and for future generaiton.

Wetland Trends

Wetlands are dynamic environments subject to change by both natural processes and human actions. These forces interact to cause wetland gains and losses as well as to degrade and improve their quality. In general, the overall effect in Delaware has been a loss and degradation of wetlands. Table 2 outlines major causes of wetland loss and degradation in the state.

Table 2. Major causes of wetland loss and degradation in Delaware (adapted from Zinn and Copeland 1982; Gosselink and Baumann 1980).

Natural Threats

1. Subsidence (including natural rise of sea level).
2. Erosion
3. Overwash from sandy barrier beaches.
4. Hurricanes and other storms.
5. Biotic effects, e.g., muskrat and snow good "eat-outs" and common reed invasion.

Human Threats

Direct:

1. Discharges of materials (e.g., pesticides, herbicides, other pollutants, nutrient loading from domestic sewage, urban runoff, agricultural runoff, and sediments from dredging and filling, agricultural and other land development) into waters and wetlands.
2. Filling for dredged spoil and other solid waste disposal, roads and highways, and commercial, residential and industrial development.
3. Dredging and stream channelization for navigation channels, flood protection, agricultural development, coastal housing developmens and pond maintenance.
4. Construction of dikes, dams, levees and seawalls for flood control, waterfowl impoundments, water supply, irrigation and storm protection.
5. Drainage for crop production, timber production and mosquito control.
6. Flooding wetlands for creating lakes, ponds, and waterfowl impoundments.

Indirect:

1. Sediment diversion by dams, deep channels and other structures.
2. Hydrologic alterations by canals, spoil banks, roads and other structures.
3. Subsidence due to extraction of ground water.

Tidal Wetlands

Statewide, tidal wetlands losses amounted to an estimated 444 acres annually between 1954 to 1971. After the Delaware legislature enacted the Wetlands Act of 1973 to provide special protection to coastal tidal wetlands, those human induced losses dropped to an average of 20 acres annually, a dramatic reduction of losses to only 4.5% of the pre-Wetlands Act period and a fairly successful record by any standard.

Non-tidal Wetlands

Freshwater non-tidal wetlands in Delaware have faired far worse than tidal wetlands. From just the period between the mid-1950's to the late 1970s/early 1980s, preliminary research estimates indicate a 20% loss of Delaware's freshwater wetlands statewide. The statewide average net loss rate may be as high as 1,500 acres per year. Losses are attributed to channelization projects and forestry practices, while agricultural conversion and urban development of freshwater wetlands were more localized.

As much as two-thirds of Delaware's original freshwater wetlands may be gone. Considering non-hydric soil inclusions within hydric soil areas, it is likely however that the actual loss is somewhat less, perhaps in the 40-50% range. In any event, Delaware's freshwater wetlands have been significantly reduced and the remaining areas need to be protected. This emphasizes the need to insure the protection of the Murderkill River Corridor.

Areas of Concern

1. Ditching of wetland for drainage only.
2. Loss of water and lowering of the water table (through ditching) and shallow aquifer for loss for individual wells for irrigation and industry.
3. Inadequate stormwater runoff program.
4. Decrease in water quality within the Murderkill basin and downstream effects upon commercial and recreational fin and shellfish fisheries.
5. Loss of general wildlife habitat and negative effects on wetland dependent species.
6. Loss of high value wetlands.
7. Negative impacts on rare, threatened or endangered species of plant and animals.
8. Residential and/or urban development in wet areas (or wetlands) that will require expensive drainage and maintenance and thus will threaten adjacent wetlands.
9. Mitigation of wetland losses and high wetlands replacement costs.
10. Loss of natural shorelines through bulkheading resulting in loss of water quality and natural habitat.
11. Wetland damage through improper silviculture harvesting techniques.
12. Excessive sedimentation influx of wetlands due to improper soil cultivation practices.

Management Options

1. Limits or prohibitions on urban or residential development in wetlands and 100 year flood plains.
2. Development of stormwater management plan and ordinances enforced in conjunction with sediment and erosion control plans.
3. Development of water conservation and control plans to minimize detrimental effects of drainage ditching.
4. Increased awareness, identification and protection of wet-

lands.

5. Best Management Practices (BMP's) employed in silviculture and agriculture adjacent to or in wetlands as a means of protecting and enhancing public and private natural resources.
6. Protection of shoreline loss; discouraging bulkheading and using alternative shoreline stabilization techniques and practices in areas of erosion and sedimentation.

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MOSQUITO PROBLEMS

William H. Meredith, Fish and Wildlife, Mosquito Control Section, Delaware Division of Fish and Wildlife, DNREC

Problems with pest mosquitoes along the Murderkill River Corridor are caused by salt-marsh mosquitoes breeding on several hundred acres of tidal wetlands in the lower basin (see Map # 1). The primary salt marsh pest species are Aedes sollicitans and Aedes cantator. They are strong fliers that bite night and day. Periodic broods of these species occur when the infrequently-flooded, high salt marsh is rewetted after a dry period, either by rainfall or flooding tides. These species do not breed in the low, frequently-flooded salt marsh, nor are they problems in man-made impoundments that maintain high and stable water levels. These mosquitoes can occassionally cause extreme and widespread annoyance to residents of Bowers Beach and South Bowers along the coast, and to inhabitants of Frederica, further inland. Besides nuisance problems, these species can transmit diseases such as encephalitis to man and horses, and canine heartworm to dogs.

Most of the salt-marsh breeding area shown on Map #2 has been parallel-grid ditched in earlier attempts to drain the marsh surface of breeding waters, thus limiting mosquito production. This effort has met with only limited success in terms of mosquito control, and has had undesirable secondary environmental impacts. Today, the Delaware Mosquito Control Section must spray these marshes several times between May and September, using aerially-applied chemical insecticides. The spraying is done only if a major brood is in progress. Control with insecticides requires constant surveilance, is costly, offers only temporary relief, and may have hidden environmental drawbacks.

Future salt-marsh mosquito control by the Section will emphasize installation of a system of selectively-excavated ponds and ditches in documented breeding areas. This technique is known as Open Marsh Water Management (OMWM), and involves no structures above the level of marsh surface that would impede marsh surface floodover. Most of the ponds and ditches used in OMWM have no or only limited connections to normal tidal flow, but are routinely flooded by the higher full and new moon tides. This very effective approach relies on biological control of mosquito larvae by fish predation. The most common fish predator of Delaware's high marshes is the mummichog or killifish, which is an abundant resident of permanent high-marsh ponds and deeper tidal creeks. The OMWM alterations eliminate many of the desirable egg deposition sites for aedine mosquitoes, and fishes in close proximity to breeding sites will consume those larvae that do emerge. OMWM is a more permanent mosquito control strategy and should greatly reduce the use of chemical insecticides over the lower basin. Additionally, the OMWM method restores standing water to the high marsh that was removed by the parallel-grid ditching, restoring or creating beneficial habitat for waterfowl, wading birds and shorebirds. It may take several years until the

Section is able to treat the Murderkill's breeding marshes with OMWM; until that time, chemical control must be used.

Production of several species of upland or freshwater mosquitoes occur along the more landward reaches of the corridor, with the most troublesome breeding period from early spring to early summer. The typical breeding habitat for these species is the temporary waters of woodland pools, or in the standing water of freshwater swamps and marshes. Selected woodland breeding areas in the upper basin are sprayed by helicopter during the early spring as part of the Section's spring woodland control program. Later in the season, little effort is made by the Section to control mosquitoes along the upper corridor because "people problems" usually do not exist in this portion of the basin and mosquito populations remained tolerable. When a local problem is encountered, chemical insecticides applied by a fog truck or helicopter are used to treat specific areas.

Attempts to control other biting flies such as gnats, greenheads and deer flies are not made by the Section, although private landowners or campground operators may attempt some control. These pests, which can locally be very annoying, do not have the flight range nor disease potential of salt-marsh mosquitoes.

Management Options

1. Continue to emphasize Open Water Marsh Management in order to keep mosquito control with pesticides to an absolute minimum.

URBANIZATION

Kent County Planning Office

The Kent County Zoning Ordinance, adopted by the Kent County Levy Court in 1972, governs land use, and industrial and residential development.

Twelve types of districts are defined with details on permitted uses, accessory uses, permitted signs, and conditional uses. Lot sizes for residential categories and yard sizes for industrial developments are specified. The 12 districts are:

- Agricultural-Conservation
- Agricultural-Residential
- Single-Family Residential
- Multiple-Family Residential
- Residential Mobile Home
- Planned Unit Development
- Neighborhood Business
- General Business
- Limited Industrial
- General Industrial
- Historic Preservation
- Midrise Multiple-Family Residential

Practicallly all land in the Murderkill River Corridor is classified in the Agricultural-Conservation District with the exception of lands within the towns of Bowers and Frederica. These municipalities administer their own land use regulations. Several individual industrial sites are developed, including sand and gravel operations, the International Latex Corporation and the Kent County Sewage Treatment Plant.

Some strip development for single family dwellings is occurring along county roads in the corridor. These developments in the Agricultural-Conservation District require a minimum lot area of one acre with a minimum road frontage and lot width of 150 feet and a minimum lot depth of 175 feet. Lot area of less than one acre is permitted for single family dwellings or mobile homes in approved subdivisions of five lots or more. The map of existing development in Kent County illustrates the occurance of strip development in the corridor.

A few housing developments have been built along lakes and scenic stretches near streams. The majority of residential subdivision developments within the watershed occur in the northwesterly reaches in the areas of Woodbury and Andrews Lake. To ensure that such developments are undertaken in accordance with all applicable state and local regulations, every proposed subdivision in Kent County is subject to plan review by the Development Advisory Committee and must receive approval from the Regional Planning Commission prior to plan recordation. Commercial and industrial site plans for which total floor area exceeds 5,000 square feet are subject to the same review and approval procedure. This review process has been established to

minimize the impact of development on existing communities and the natural environment.

The Kent County Zoning Ordinance also regulates development within flood plain areas. The ordinance contains specific requirements for the construction and/or placement of structures within flood plains. It also addresses the use of fill for elevation purposes, minimum floor elevations and proper anchoring of structures.

New construction in Kent County is reviewed and inspected under the enforcement of the Building Officials and Code Administrators code, which governs proper construction methods. Recently, Kent County adopted the State Housing Code which establishes minimum property maintenance standards to ensure public safety, health and welfare. In addition, Kent County has implemented the Land Evaluation and Site Assessment (LESA) procedure as an aid in the decision making process for specific land use issues.

Management Options

1. Kent County is updating its Comprehensive Land Use Plan. Residential strip development is a topic of particular attention at this time. The Regional Planning Commission is studying alternatives which would reduce the proliferation of this type of development in the county.

FLOODPLAIN MANAGEMENT

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Division of Soil and Water Conservation, DNREC.

Introduction

A floodplain is an area of land that, from time to time, has been or can reasonably be expected to be underwater. This simple definition covers areas that are overflowed by streams at times of high discharge, those areas covered by abnormal tidal action, areas flooded by tides caused by winds, and even areas that are flooded by impairment of drainage.

The delineation of a floodplain to some degree is an arbitrary procedure. For practical purposes the area covered by a flood with an average recurrence interval of 100 years has been defined as a floodplain by many. The jurisdiction within the Murderkill Corridor all regulate the 100 year flood as a flood that has one chance in one hundred or a one percent chance of being equaled or exceeded in any given year.

The regulations of the 100 year floodplain as we know it today is the result of the National Flood Insurance Program (NFIP) administered by the Federal Insurance Administration of the Federal Emergency Management Agency. The NFIP enables property owners to purchase flood insurance as long as his community implements a program to reduce flood risks. All of the communities that have identified flood risks in Delaware participate in the National Flood Insurance Program. For the Murderkill River Corridor this includes: The Town of Bowers, since February 2, 1980, the Town of Frederica, since January 2, 1981, and all of the unincorporated areas of Kent County, since March 15, 1978. Without community oversight of building activities in the floodplain, the best efforts of some to reduce flood losses could be undermined by others.

Each community has entered the NFIP on a voluntary basis. After assessing their flood hazards and the effects of loss of Federal assistance in flood prone areas, each community in Delaware chose to accept the responsiblity of floodplain management in order to provide the best benefits to the community.

Extent and Condition

A national program created a floodplain management system in the Murderkill River Watershed rather than the recognition of a local need to establish an organized flood protection program. This however, has brought attention to the local conditions.

Parts of the Murderkill River Watershed are subject to all four types of flooding: overflowed streams, abnormal tidal action, wind blown tides and impairment of drainage. The flooding caused by poor drainage is outside of the area defined by the Murderkill River Corridor. This flooding problem is being addressed by the USDA/SCS under a PL-566 Small Watershed project. Of the remaining 3 types of flooding, abnormal tidal action and wind blown tides have the largest impact in the corridor especially when the two types of flooding occur at the same time.

The damages occur to the coastal communities of Bowers Beach and South Bowers (regulated by Kent Count) when a northeaster, blowing winds westward off of the Delaware Bay occurs during a spring tide. This is especially damaging when the storm lasts for two or more tidal cycles. The first elevated, wind blown tides break down the barrier shore and dune line of defenses allowing subsequen tides to cause damage to the structures in the low lying areas behind the dunes. The access roads to these communities are often flooded isolating people who have not evacuated and subjecting them to high human risks.

Since 1978, for the unincorporated areas and two years later for Bowers, new structures within floodplains had to meet floodplain management requirements. The basic components are the flood proofing of nonresidences and the elevation of residences above the 100 year flood elevation. The rate structure of the NFIP (premiums decreased the higher a structure is raised in a floodplain) has caused many homeowners of older structures to raise their homes to take advantage of the lower rates and to reduce the risks of living in a floodplain.

The fourth type of flooding, overflowed streams, periodically causes damages to structures in the Town of Frederica and to a few homes located within the floodplains of the Murderkill Corridor. Observations have indicated that demand currently for development in the stream valley floodplain is low, however, a few isolated homes have been built in the steam valley with the appearance of risk caused by flooding.

Major Problems

Major problems in floodplain management exist in and around the coastal communities of Bowers and South Bowers. The raising of a residence above the calculated 100-year flood level does not necessarily prevent the hazards to these structures. Hurricanes delay the calculated risks mitigated by a floodplain dweller especially of a coastal community. The risks normally mitigated against is also compounded due to dynamic conditions which are occurring on both the land and the sea. In the last century, the water level at Bowers has increased 1.5 feet. Sea level rise is predicted to increased 3-5 feet in the next 100 years. Combine sea level rise with land subsidence at the rate of 1/2 foot per century and the commonly used practice of elevating structures on pilings, which in South Bowers is in a foundation of marsh muds causing in one instant a sinking of the pilings by 2 feet over a sixteen year period, will dramatically negate current floodplain management practices of these coastal communities.

Another problem that exists within the Murderkill River Corridor is that the jurisdiction with the responsibility of floodplain management are not large enough to justify the aquisition of technicians with floodplain managment abilities. With Kent County having only 100,000 people, Bowers with less than 200 and Frederica with 1,000 people and only a very small percentage of the populations of these communities living in the floodplains, the number of times that the person responsible for carryout out floodplain management within these communities, and who have many other responsibilities on a daily basis, over shadow

the importance of floodplain management abilities that occur on an occasional basis.

Management Options

1. A near term management option to increase the effectiveness of current floodplain management objectives is the use of the conservation district technicians as a resource to the local communities in more adequately the tools (flood hazard maps, flood elevations, reference elevations, management alternatives, etc.) that exist to reduce flood hazards.
2. A long-term management option is the active pursuit of a solution to the coastal community dilemna caused by increasing flood levels. Economics may be the focal point by which remedial solution benefits should be compared to the cost of measures required to reasonably protect against coastal high hazard conditions. The Division of Soil and Water Conservation, Beach Preservation Section is seeking funds to study the problem. Local support and assistance may be needed to fully understand the situation. This coordination need may be a role for the conservation district.

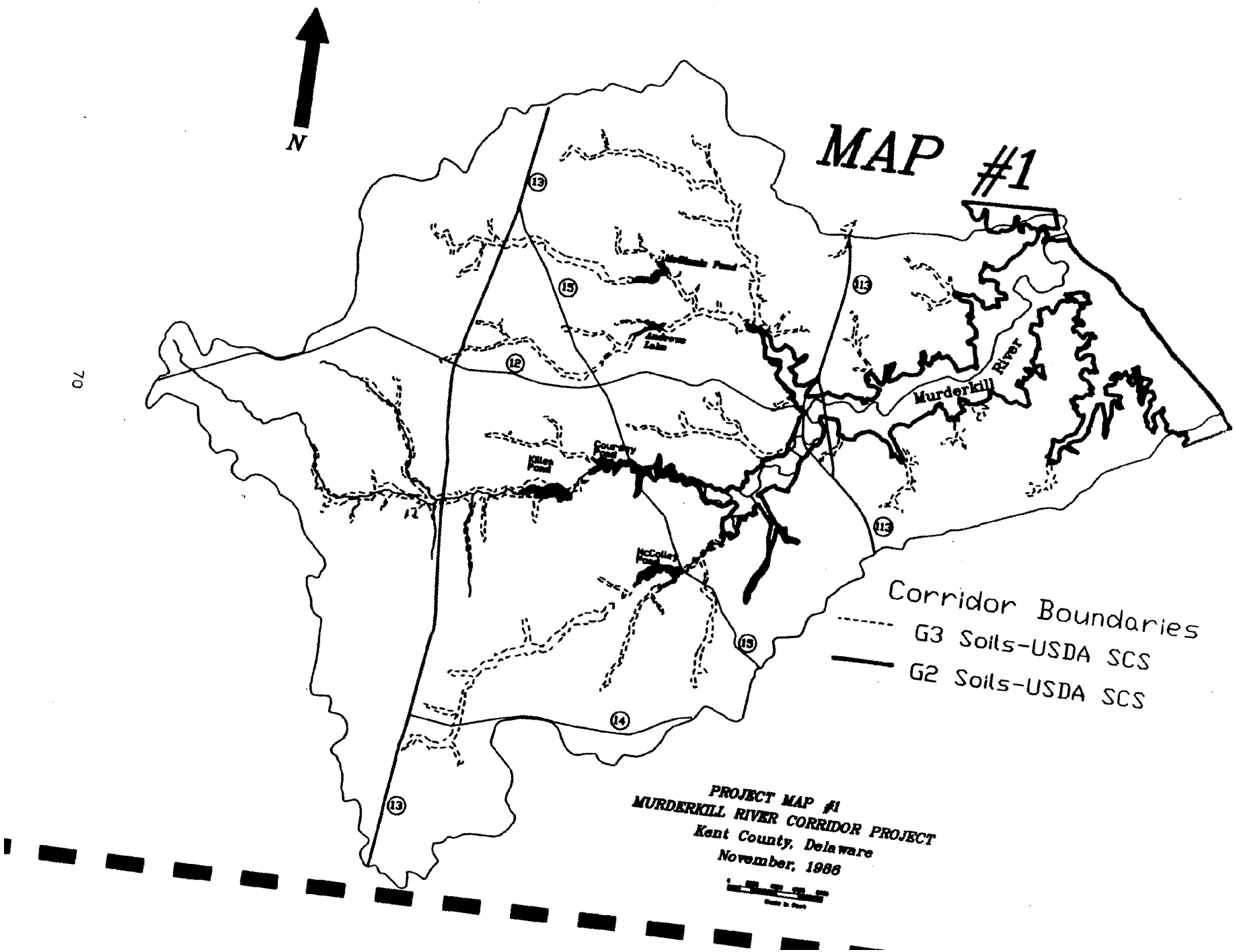
REFERENCES

Federal Emergency Management Administration, Federal Insurance Administration. Questions and Answers on the National Floodplain Insurance Program FIA. 1983.

Kent County, Delaware. Zoning Ordinance, adopted Feb. 8, 1972.

National FloodPlain Management Conference. Proceedings. Washington D.C. 1974.

USDA, Soil Conservation Service. Floodplain Management, Why We Need It. SCS Program Aid No. 1276. 1986.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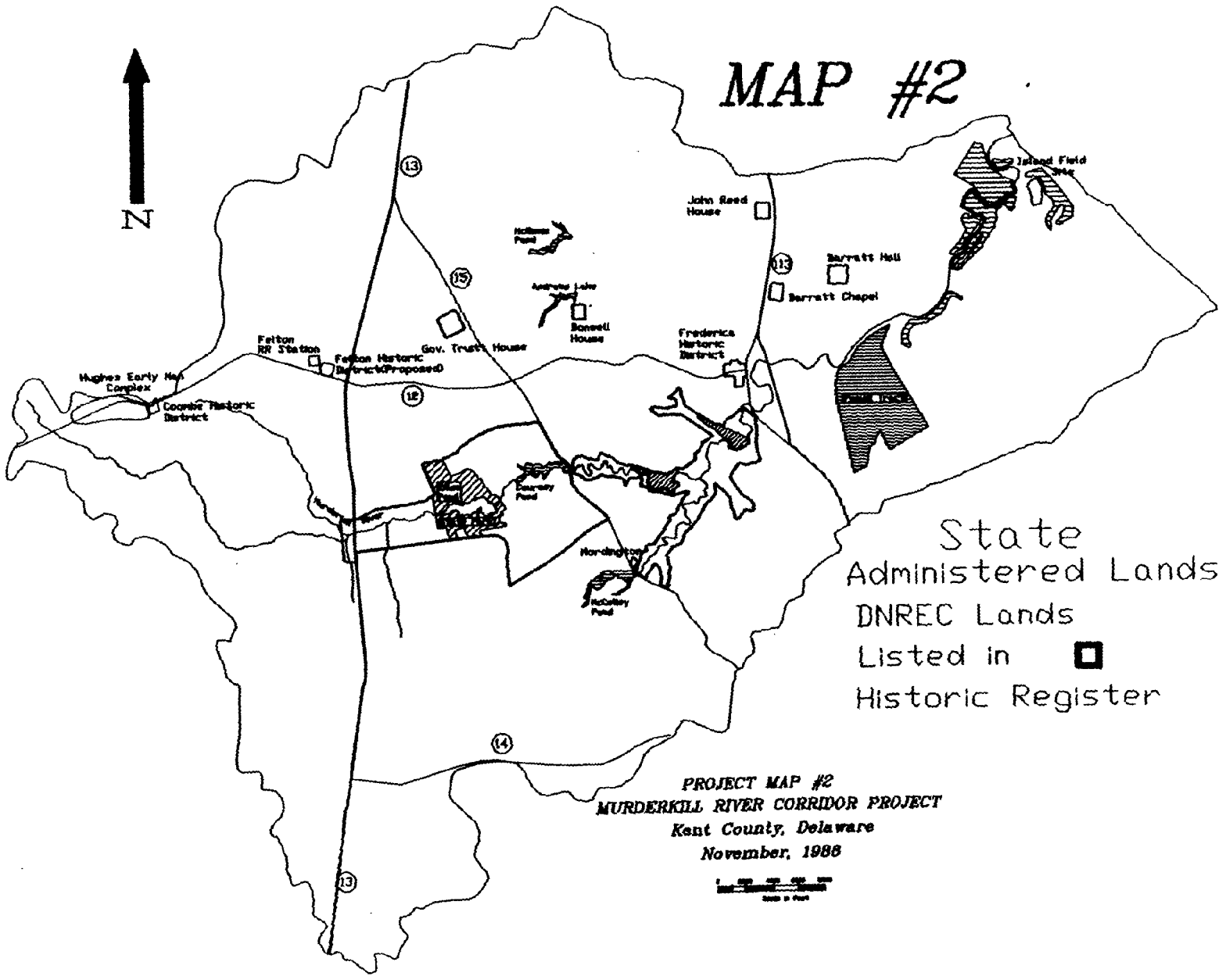
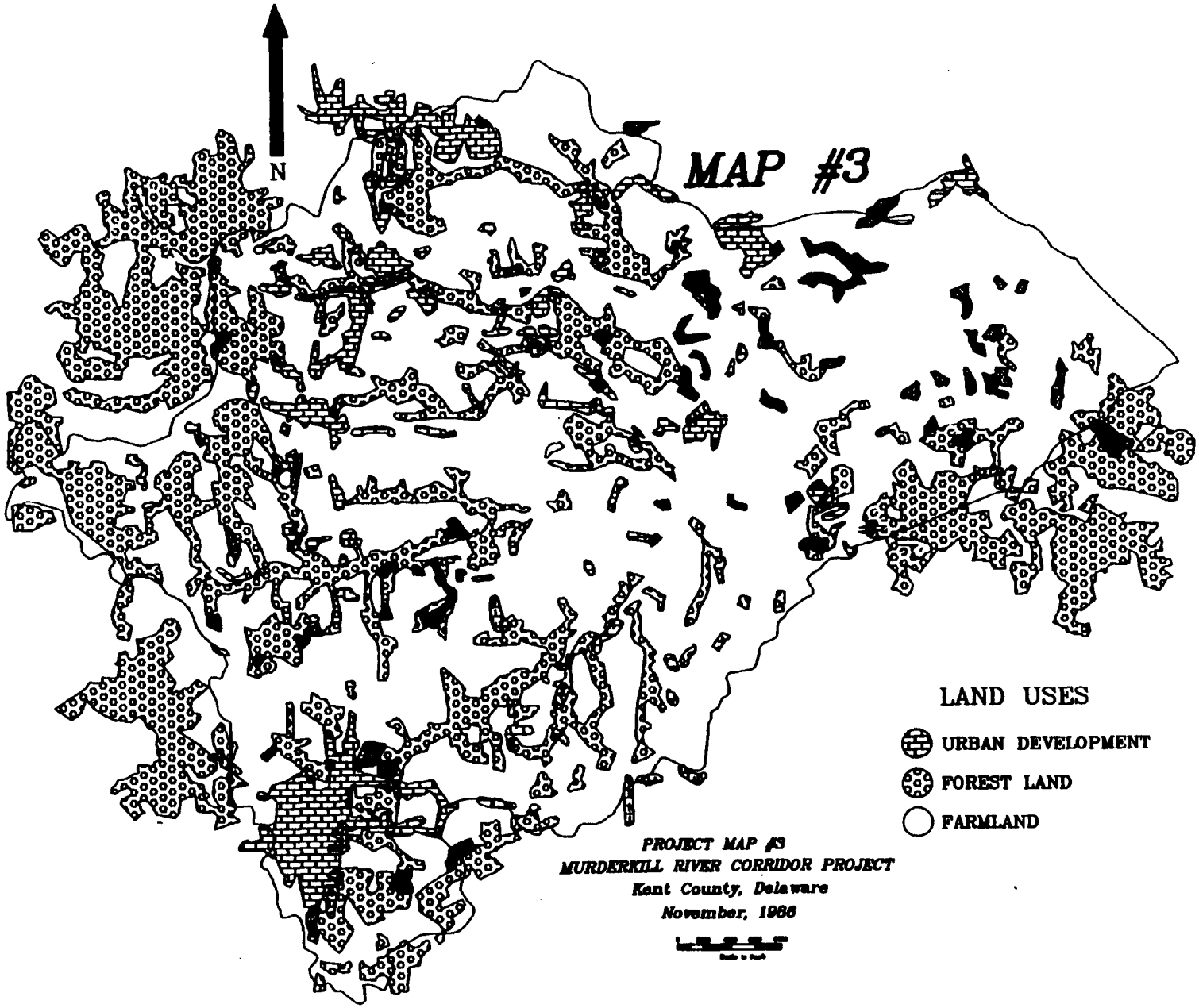
MAP #1
Murderkill River
Corridor Boundaries
G3 Soils-USDA SCS
G2 Soils-USDA SCS
PROJECT MAP #1
MURDERKILL RIVER CORRIDOR PROJECT
Kent County, Delaware
November, 1986


MAP #2
N
John Reed House
Barratt Hall
Barratt Chapel
Bonnell House
Gov. Truitt House
Felton RR Station
Felton Historic District(Proposed)
Frederica Historic District
Hughes Early Mill Complex
Coombe Historic District
State Administered Lands
DNREC Lands
Listed in
Historic Register
PROJECT MAP #2
MURDERKILL RIVER CORRIDOR PROJECT
Kent County, Delaware
November, 1988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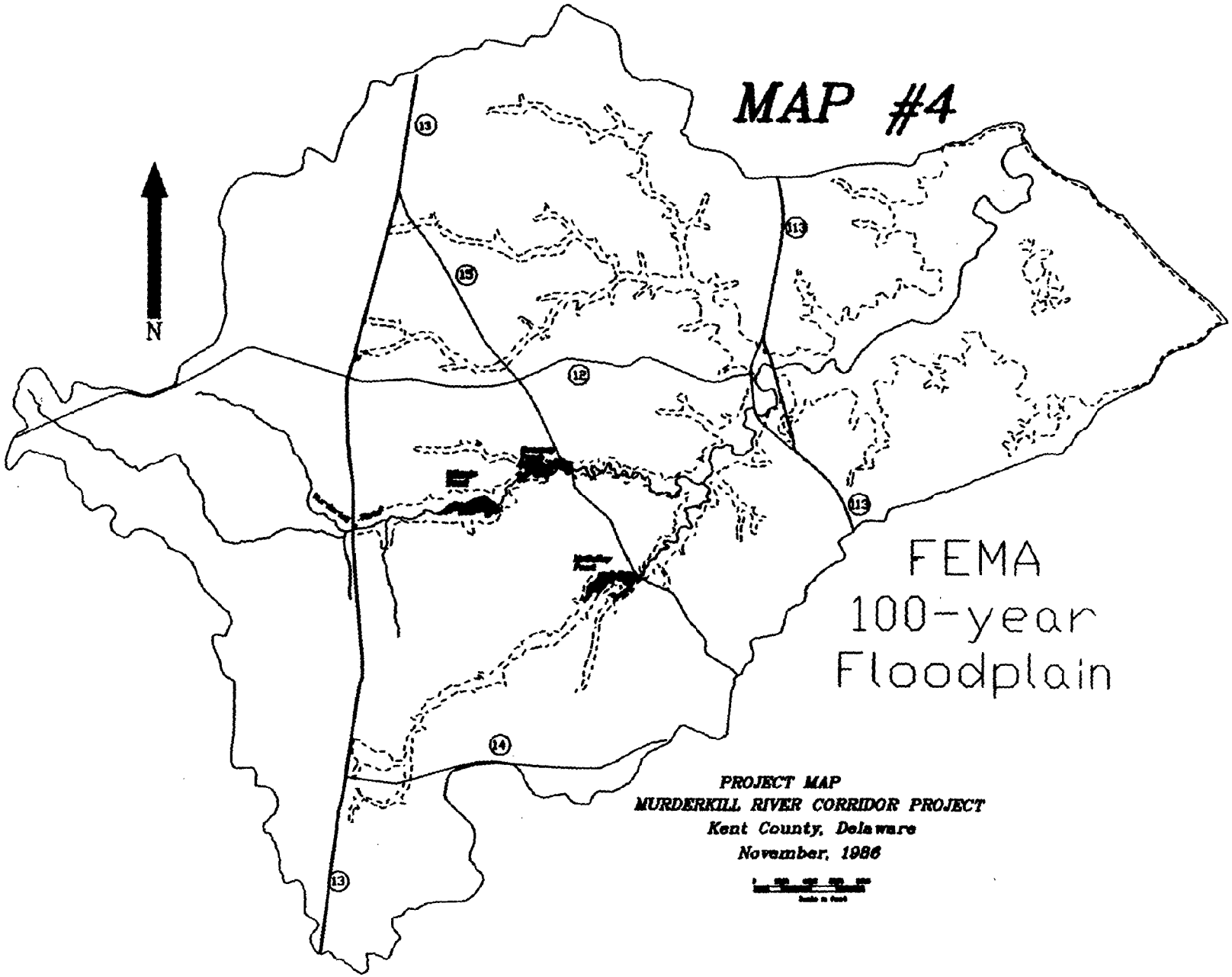
MAP #3
LAND USES
URBAN DEVELOPMENT
FOREST LAND
FARMLAND
PROJECT MAP #3
MURDERKILL RIVER CORRIDOR PROJECT
Kent County, Delaware
November, 1986


MAP #4
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FEMA
100-year
Floodplain
PROJECT MAP
MURDERKILL RIVER CORRIDOR PROJECT
Kent County, Delaware
November, 1986